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POWER AND THE ENGINEER

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Vol. 29. Index to Advertisers and Classified Index Following Reading Matter No. 12.

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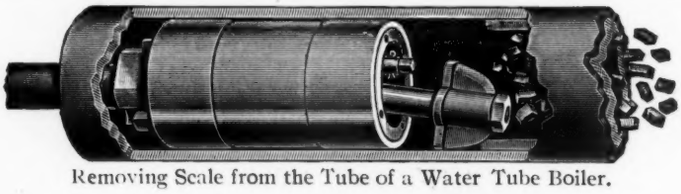

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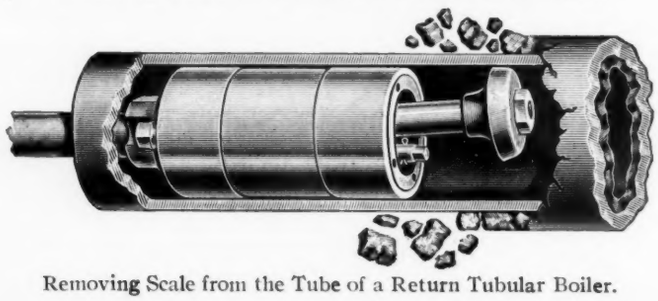

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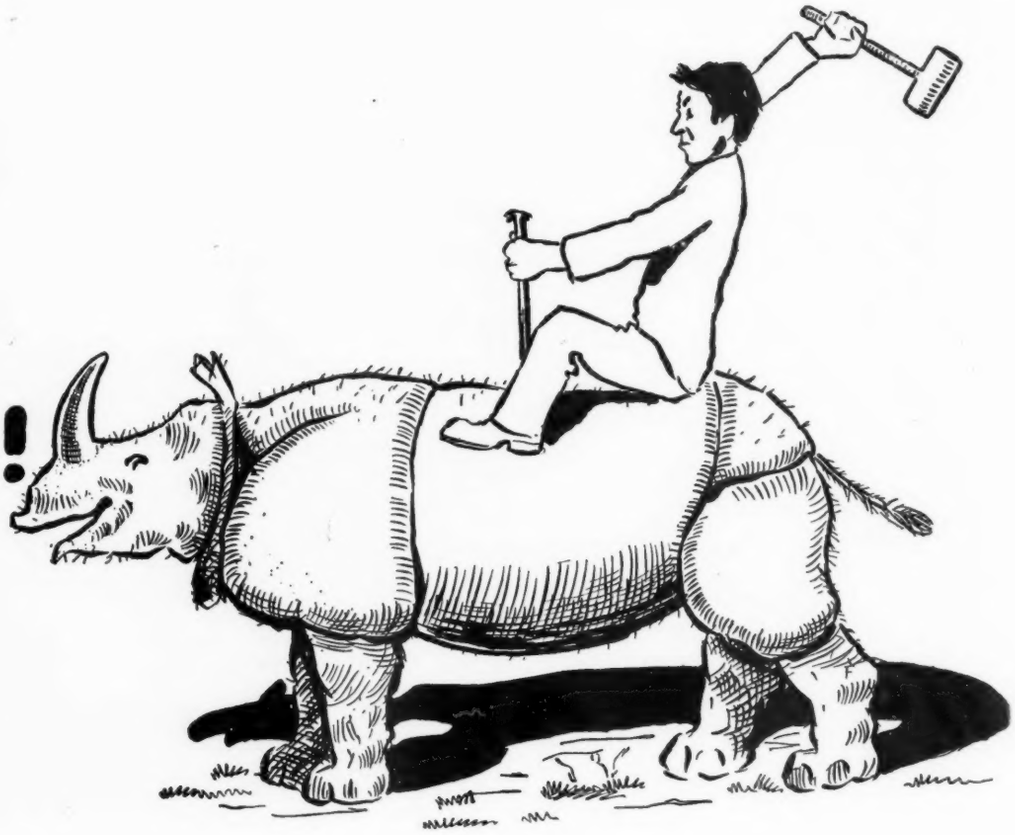

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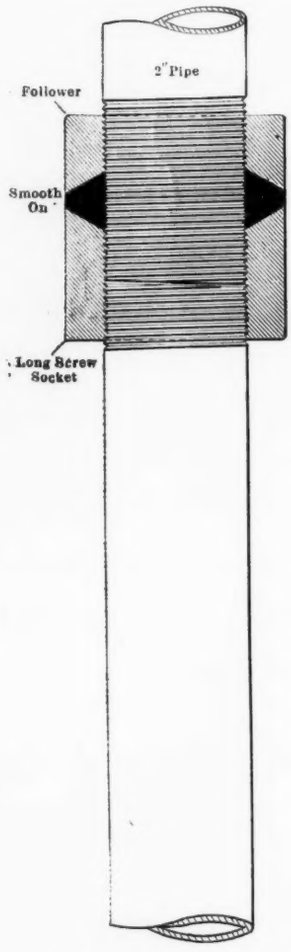

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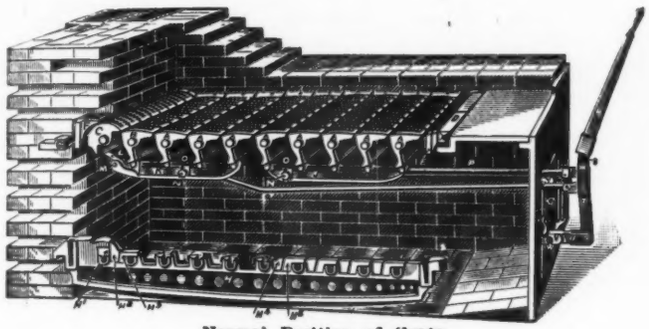
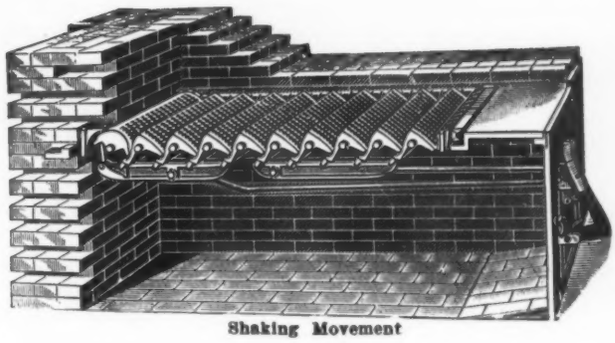


Normal Position of Grate



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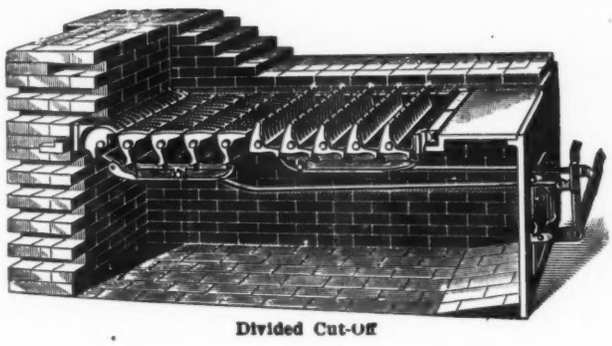
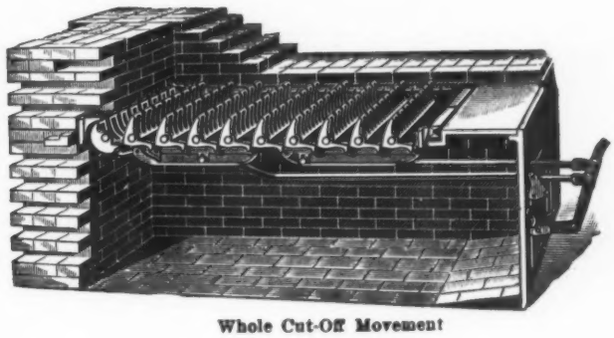


Divided Cut-Off



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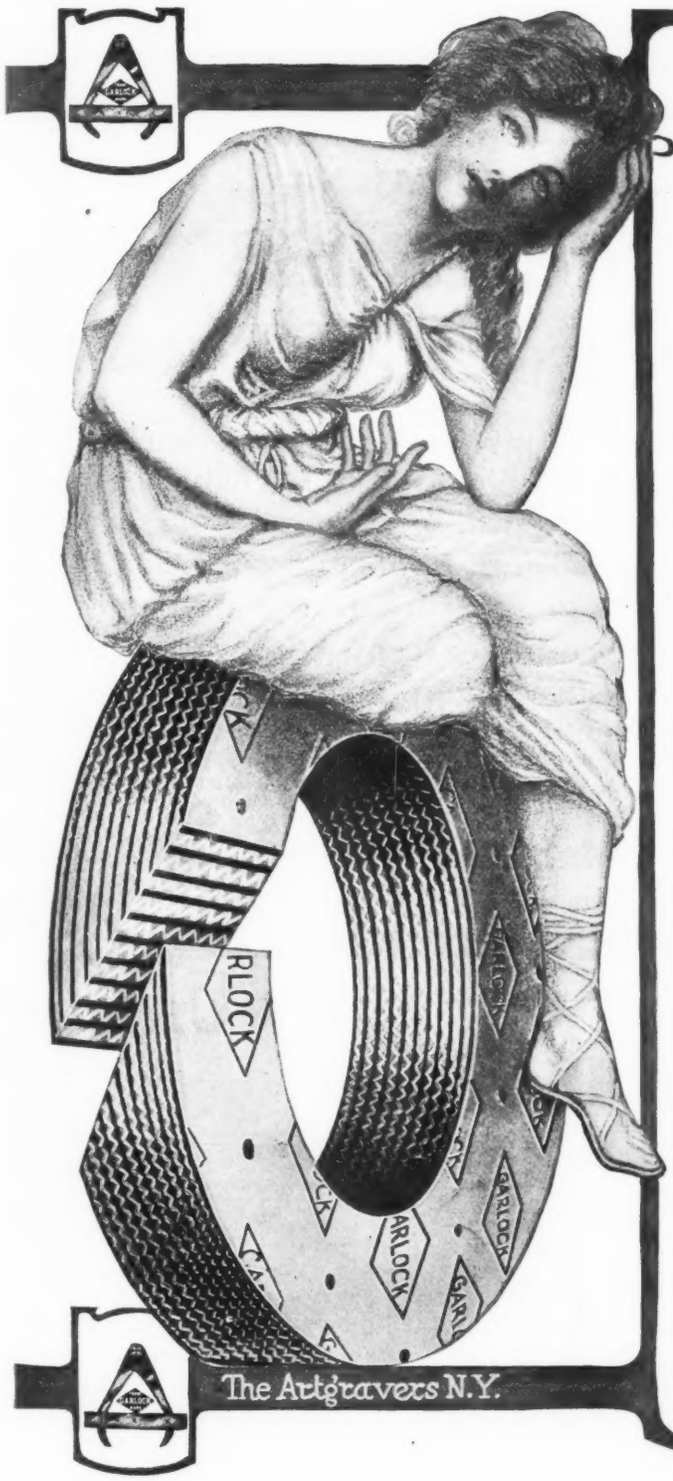

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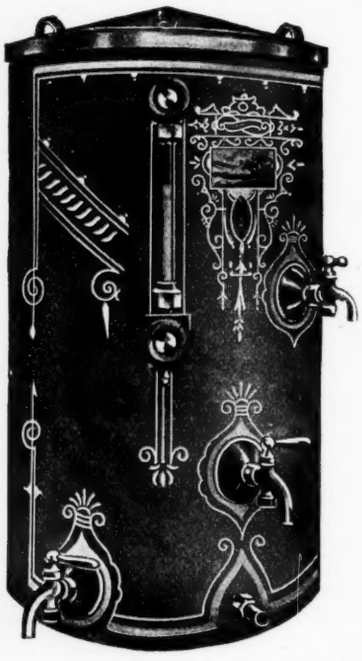

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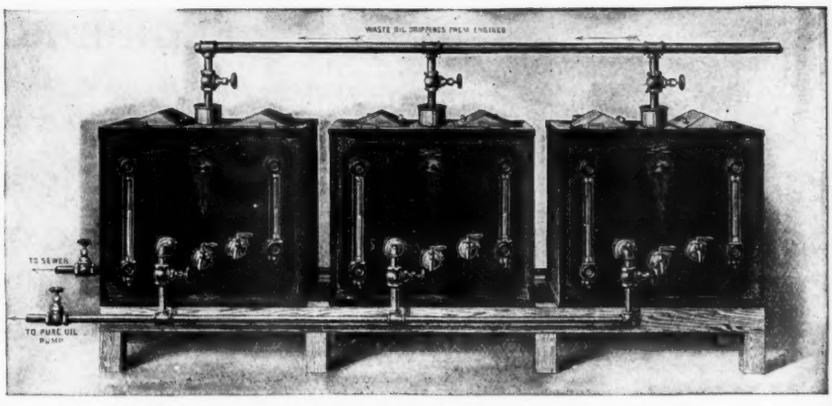

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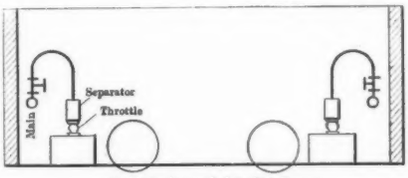
The Piping Systems of High Pressure Plants

Directions for Arranging Steam and Water Piping for Power Plants, Showing the Most Desirable Methods for Various Conditions

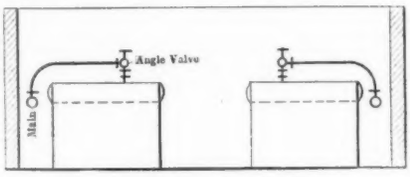
BY CHARLES L. HUBBARD

The design of a system of piping for a high-pressure steam plant is a matter of much importance, and should be carefully worked out in detail before any of the apparatus is installed. The boilers and engines and their auxiliaries should first be located on the drawings in their true positions, and then connected in a manner best suited to the existing conditions.

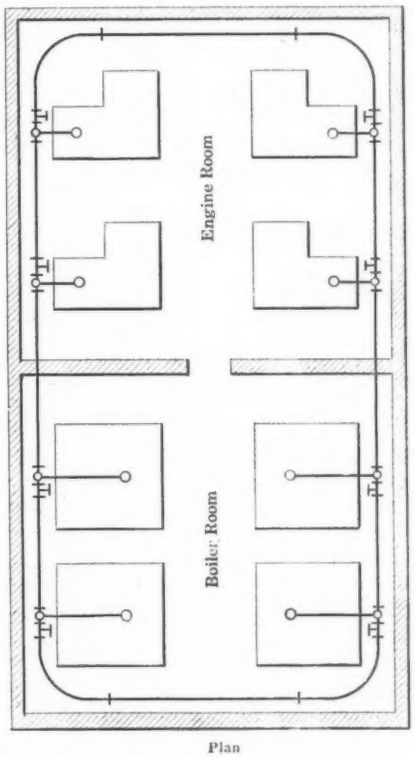
Piping plans of medium size are usually laid out to a scale of ⅜ or ½ inch to the foot, and all valves and fittings drawn in their true proportion to make sure that there is sufficient space for the work to be made up. The principal points to be kept in mind when laying out a system of this kind are as follows: Pipes of sufficient size to prevent loss of pressure; reasonable compactness, to avoid excessive condensation; provision for expansion; freedom from pockets for the collection of water; and a system of drainage which shall keep the pipes free from condensation under all conditions.



Section through Engine Room



Section through Boiler Room



Plan

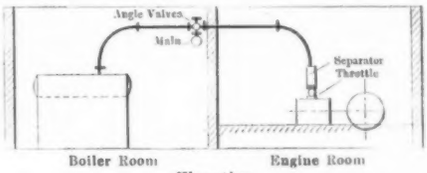
FIG. 1. BOILER AND ENGINE ROOMS END TO END

In electric-power plants of medium size, the arrangement of boilers and engines is much the same, and usually follows one of two general schemes. In one case the boiler and engine rooms are placed end to end, with boilers and engines lying in the same direction, as shown in Fig. 1, while in the other arrangement they are placed back to back with a wall between, as indicated in Fig. 2. When the plant is located in the basement of an office building, or forms part of the power and heating system of some public building or institution, these arrangements cannot usually be carried out in full, and various modifications are necessary in each particular case. However, these diagrams will be found useful in many instances, even though the conditions are quite different, and will serve as a basis in laying out work of this kind.

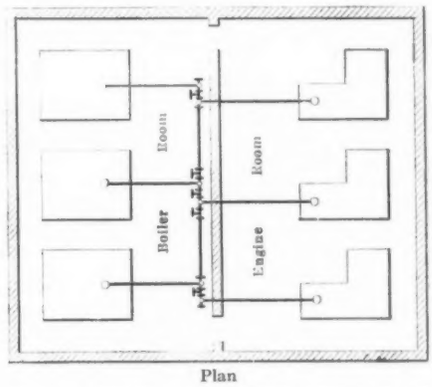
Ring System of Piping

The system of piping shown in Fig. 1, is known as the "ring" system. In this arrangement the steam passes from the boilers to the engines by two paths, and any section of the main may be cut out by closing two of the valves. The main, in this case, must be made full size for its entire length, and the cut-out valves are necessarily of the same size, which adds considerably to the first cost. On the other hand, it practically serves the purpose of a duplicate system of piping, and in case of a leak or accident, the damaged section can be cut out by sacrificing a single engine or boiler according to its location.

Another arrangement of the ring system is shown in Fig. 3, where the boilers and engines are placed in much the same manner as in Fig. 2.



Elevation



Plan

FIG. 2. BOILER AND ENGINE ROOMS BACK TO BACK

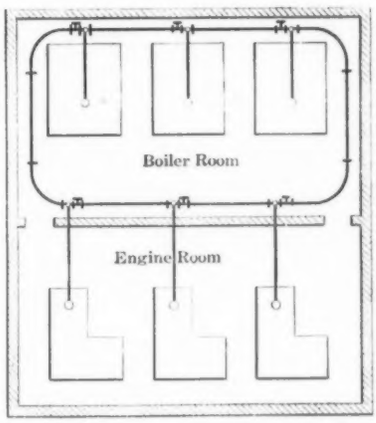


FIG. 3. RING SYSTEM OF PIPING

In the back-to back method the main or header is commonly carried on brackets secured to the boiler-room wall. In this arrangement each boiler and engine has its valved connection with the header. which is common to all. In small plants

the header is usually made in one section, but where it is desired to guard against accidents as far as possible, it may be divided into sections, as shown in Fig. 2. In this case only one boiler and engine will be thrown out of use by a break in the main, provided those connected with each section are properly proportioned. The main may be placed overhead, as shown in Figs. 1 and 2, or supported upon piers or brackets at the rear of the boiler settings. The latter arrangement is commonly used in large plants where the engine-room floor can be placed at a higher level than that of the boiler room. This allows the connections to be carried beneath the floor and does away with heavy exposed piping in the engine room. In this way the room can be kept cooler, and in case of leaks or breaks the escaping steam does not reach the electrical apparatus so readily. Although having these advantages, it cannot usually be employed in office buildings and similar locations on account of the limited space. In making provision for expansion, it is customary to use pipe bends and swivels so far as possible, in preference to slip joints.

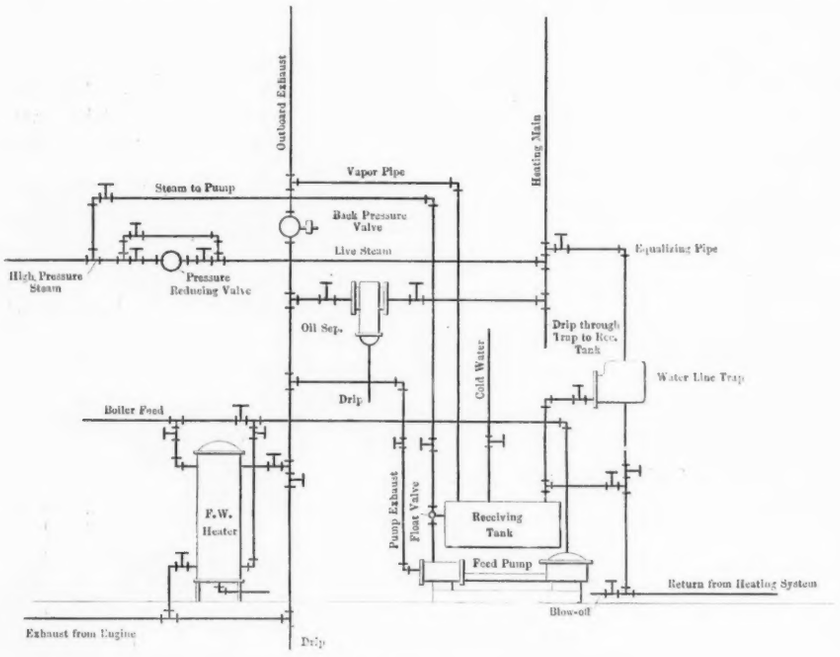


FIG. 4. CONNECTIONS FOR NON-CONDENSING PLANT

Boiler and Engine Connections to Header

Common methods of connecting boilers with the main are shown in Figs. 1 and 2. In the first case an angle-valve is placed directly upon the boiler nozzle, and the lead drops into the top of the main by means of a sweep bend. If head room is limited, an elbow may be substituted for the angle-valve, and a gate-valve placed just beyond it, with the stem in a horizontal position. Some engineers place two valves in the lead, as a precaution against leakage of steam from the main into the boiler while the latter is shut down for inspection or repairs.

Connections to the engine should always be taken from the top of the main, and if suitably located, a full U-bend may be used, as shown in Fig. 1, with a gate-valve in the pipe near the main in addition to the throttle at the engine.

When there is sufficient head room the pipe bend is often connected directly to the boiler nozzle, as shown in Fig. 2, and connection made with the top of the main either by means of an angle-valve or an elbow and gate, the latter being placed in the horizontal portion of the pipe near the main. The illustrations given show only a few of the methods in common use, and may be varied or combined in different cases to meet the requirements.

In small plants where moderate pressures are carried, cast-iron fittings may often be used in place of pipe bends, provided special care is taken to use swivel joints wherever possible. Rigid connections should be avoided in every case, and the engineer must always have in mind the flexibility of the piping under expansion and contraction.

Steam separators are commonly placed close to the throttle of the engine, and not only serve to remove the moisture, but when of large size they provide a reservoir of steam close to the cylinder which insures a higher and more uniform pressure up to the point of cut-off, and also lessens the vibration in the steam pipe caused by the intermittent flow of steam to the cylinder.

Exhaust Steam Piping

In different cases the exhaust piping will vary considerably, depending upon whether the plant is to be run condensing or non-condensing, and also upon the disposal of the exhaust steam in non-condensing plants. When there is a sub-basement under the engine room, the exhaust piping may be carried in this space, together with the steam connections, otherwise they are run in covered trenches below the floor. The general method of making the exhaust connections under different conditions can best be illustrated by a few diagrams.

Fig. 4 shows the method of connecting up a non-condensing plant in which the exhaust steam is used for heating purposes. The exhaust main from the engines is carried beneath the floor and is so valved that the steam can be passed either outboard through a back-pressure valve, or into the heating system through a grease extractor.

Feed-water Connections

A closed feed-water heater is connected with the main so that either a part or the whole of the exhaust can be made to flow through it. This arrangement allows the heater to be cut out in case of repairs and also makes it possible to pass all of the exhaust through it in the summer time when the heating system is not in use, if so desired.

A cross-connection is made with the high-pressure main for automatically supplying live steam to the heating system through a reducing valve in case the exhaust should prove insufficient at any time, and the returns from the heating system are trapped into a vented receiver and pumped back to the boilers automatically when the water-line in the tank rises above a given point.

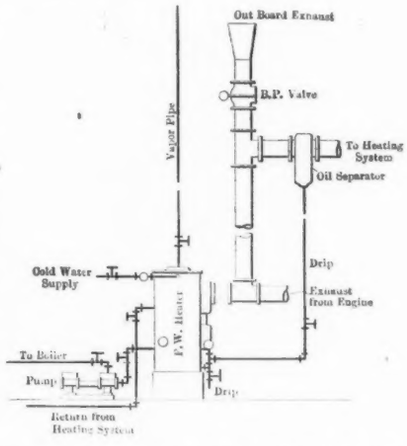


FIG. 5. SINGLE STEAM CONNECTION TO HEATER

Sometimes the feed-water heater has only a single steam connection, as shown in Fig. 5. In this arrangement, which is sometimes called the induction system, there is no circulation of steam through the heater, only enough being drawn in to take the place of that which is condensed. This condition makes it necessary to provide a vent for the gases which are liber-

ated from the steam, otherwise the heater would become air-bound. The best method of venting is to provide a small pipe from the top of the heater to the atmosphere, carrying this pipe 8 or 10 feet higher than the top of the exhaust. A valve should be placed in the vent pipe near the heater for regulating the area of the outlet. When the heater is installed on the induction system, it is necessary to place an

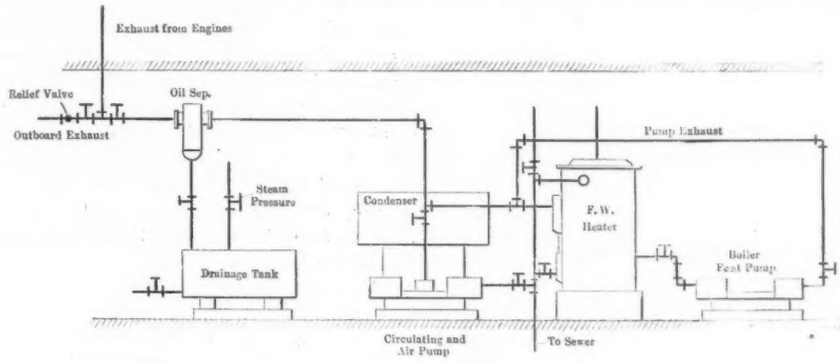


FIG. 6. SURFACE CONDENSER PLANT

independent grease extractor in the branch leading to the heating system as shown. The separator may be trapped to waste through the water-seal on the heater.

This is a good method of connecting an open heater with an exhaust-heating system, as it does away with all possibility of spray being carried over from the open pans or trays into the radiators, which might occur if the steam was passed through at too high a velocity.

Piping to Condensers

Fig. 6 shows the method of connecting a surface condenser when the discharge water is to be returned to the boilers. The piping is so arranged that the exhaust can be turned either outboard or passed into the condenser through an oil separator, as desired. A relief-valve is placed in the branch leading outboard, which opens

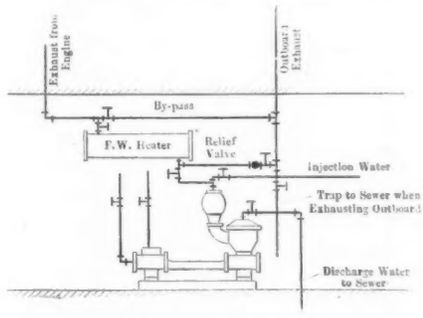


FIG. 7. JET CONDENSER DISCHARGING TO SEWER

automatically in case anything happens to the condenser. The exhaust from the air and feed pumps should be turned into a heater.

It is evident that when this system is in operation, a partial vacuum exists in the separator as well as in the condenser, hence the drip cannot discharge against atmospheric pressure, and for this reason, special provision must be made for drainage. One method of doing this is to lead the drip to a closed tank of good size with connections as shown in Fig. 6. This tank has a float-valve connected with a small steam whistle. When it becomes nearly filled with oil and water, the alarm is given and the tank can be emptied by closing the drip and equalizing pipes, opening the drain, and admitting steam pressure to the top of the tank. Another method which operates automatically, is to use a good form of return trap in place of the tank. In this case, steam at a very low pressure should be connected with the trap for discharging its contents.

Fig. 7 illustrates the connections for a jet condenser when the discharge water is turned into the sewer. In this case no oil separator is required, and a primary feed-water heater is substituted in its place. There is a connection outboard through a relief-valve as before. The exhaust from the pumps should be discharged into a secondary heater through which the boiler-feed should be made to pass after leaving the primary heater. In this case the arrangement is such that all condensation from the heater is carried into the condenser with the flow of steam, so that no special drips are required. If it is not convenient to place the condenser at a lower level than the engine, it may stand on the same grade, the only advantage in the arrangements shown being that of drainage.

Fig. 8 shows the method of making the connections for a siphon condenser of the Knowles type. The condensing water may be taken from a tank or flume as shown, or may be supplied by a pump placed in the boiler or engine room. In some plants each engine is provided with its own condenser, while in others two or more engines are connected with the same condenser; in the latter case each engine should have a valve in the exhaust pipe near the cylinder.

Drainage

Of equal importance with flexibility is the matter of drainage. Steam pipes should always be graded, if possible, so that the flow of steam and water will be in the same direction. If this cannot well be done, the pipes should be made extra large. Pockets are to be avoided, but if for any reason they are found to be necessary in special cases, they should be effectively drained at the point where the pipe rises again. When mains of considerable size are carried for long distances, they should be dripped at intervals of 125 to 150 feet into a line running back to the boiler room; and in case the main header is divided into sections, each should have its separate drip.

Globe-valves, with the stem in a vertical position, ought never to be used in horizontal pipes, as a pocket will be formed to hold back the water of condensation; neither should a valve of any kind be used in a vertical pipe where it will form a pocket for the accumulation of water above it. This applies especially to vertical pipes above the nozzles of boilers.

Under nearly all conditions gate-valves are better adapted for use in horizontal pipes, but care should be taken not to place them with the stem vertical and the hand-wheel at the bottom, for if they are left partially closed they will form an obstruction at the bottom of the pipe. When the throttle-valve of an engine or pump is placed at the bottom of a vertical supply pipe, the pocket above should be dripped by means of a "bleeder" connected into the pipe just above the valve. This may be blown out by hand just before starting up, or the drip may be connected with a trap which will keep the pipes clear automatically. The last arrangement is always necessary in the case of elevator

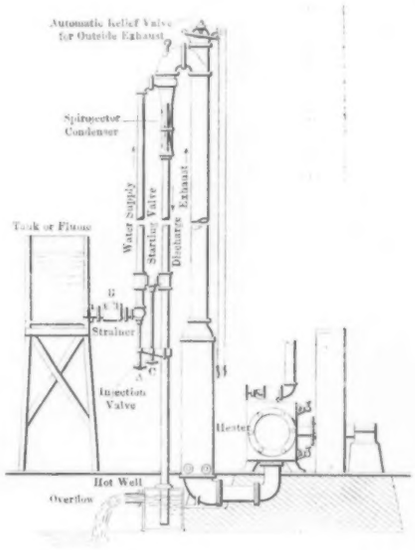


FIG. 8. SIPHON CONDENSER

pumps which run intermittently and are started automatically by a drop of pressure in the pressure tank.

Condensation from piping containing live steam is usually collected and returned to the boilers by means of a pump or return trap. When the points to be dripped are under different pressures, an automatic return pump with a vented re-

ceiver should be used, and each drip line provided with a trap discharging into it. If the drips are all under practically the same pressure and located near together, the condensation may be returned directly to the boilers by means of the "steam loop" or Holly system, or they may be connected with the receiver of a return pump without the use of traps. If this is done, the different drip lines should be brought together below the water-line of the tank and provided with check-valves. This also applies to the use of a return trap. Drips from oil separators, feed-water heaters and all other parts of the exhaust system containing oil are usually trapped to the sewer. Cylinder cocks are commonly connected with the blow-off tank, which allows the steam to pass off through the vapor pipe.

Feed-water Piping

In first-class plants the feed piping is usually of brass, although extra-heavy iron pipe is sometimes used. Long-turn fittings and gate-valves are to be preferred in this class of work. The method of connecting up the feed apparatus will vary in different cases, but the following diagrams will serve as a basis from which to make up different combinations as may be required. For simplicity only one piece of apparatus of a kind is shown, except in the case of feed-pumps, which should always be in duplicate.

Fig. 9 shows the feed connections for a non-condensing plant of the simplest kind. The supply main separates into

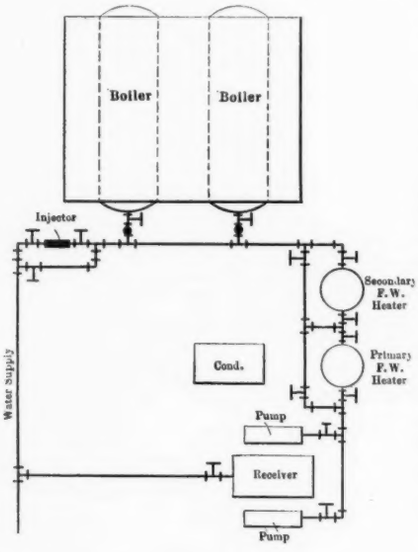


FIG. 10. FEED PIPING WITH JET CONDENSER

two branches, one leading to the receiving tank and the other to an injector near the front of the boilers. The connection with the tank may have simply a hand-valve for supplying fresh water when required, or it may be provided with a float-valve for admitting it automatically when the water line in the tank falls below a given level.

The discharge from the feed-pump is passed through a closed heater on its way to the boilers, and the branch leading to each boiler should be provided with both check- and gate-valves, the latter being placed next to the boiler and in a position easily reached from the boiler-room floor. A by-pass is shown around the injector for admitting water to the boilers directly from the main Sometimes the

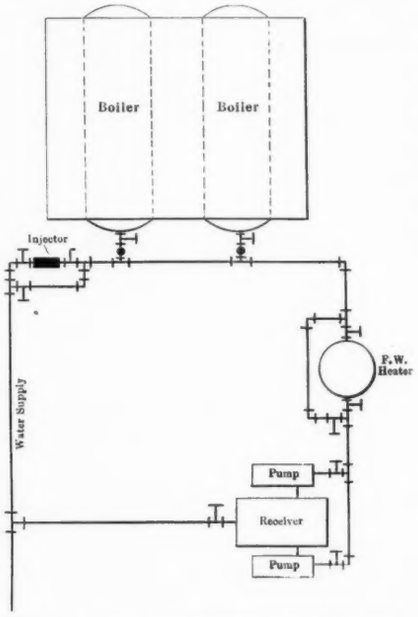


FIG. 9. SIMPLE FEED CONNECTIONS FOR NON-CONDENSING PLANT

injector is placed on a separate line; this is a good arrangement in large plants, as it admits of any boiler being emptied and refilled from the main independently of those under steam pressure. All drips and the returns from the heating system are trapped into the receiving tank. An open heater might be used in this case, taking the place of both the receiving tank and closed heater.

Fig. 10 shows the arrangement of piping for a plant using a jet condenser in which the discharge water is turned into the sewer. The only change in this case is the addition of a primary heater placed in the main exhaust pipe between the engine and condenser. The discharge from the feed-pump is first passed through this heater and then through an auxiliary supplied with exhaust steam from the air- and feed-pumps.

Fig. 11 illustrates a condensing plant in which a surface condenser is used. The exhaust from the engine is passed through an oil separator and the discharge water from the air-pump turned into a hot-well, from which it is pumped back to the boilers. A feed-water heater taking exhaust steam from the pumps is used as before. The fresh-water supply, high-pressure drips and the returns from the heating system are discharged into the hot-well instead of a receiver as before. The pump suction has a cross-connection so that it can take its supply either from the hot-well or directly from the main. In case an economizer was used supplying heat from the flue gases, it should be connected into the feed line between the exhaust heater and the boilers.

Size of Steam Pipes

For high-pressure work, the size of steam pipes, where the length of run does not exceed 100 feet, is usually based on the velocity of flow. The maximum commonly allowed is 6000 feet per minute for supply mains and 4000 feet for exhaust. In practice it is customary to make the pipes slightly larger than called for by this velocity. The following empirical formulas may be used for computing the size of steam and exhaust pipes when the cylinder dimensions and speed are known:

For a steam pipe—

$$d = D\sqrt{\frac{L \times R}{36{,}000}}.$$

For an exhaust pipe—

$$d = D\sqrt{\frac{L \times R}{24{,}000}}.$$

In these formulas

d = Diameter of pipe in inches.
D = Diameter of cylinder in inches.
L = Length of stroke in inches.
R = Revolutions per minute.

A simple method giving a slightly larger pipe than the above, but corresponding well with average modern practice, is to allow 0.12 square inch area per one horse-power for steam, and 0.18 square

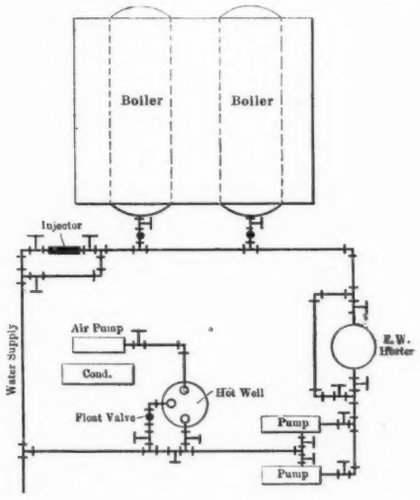


FIG. 11. FEED CONNECTIONS IN SURFACE CONDENSER PLANT

inch for exhaust pipes. The factor 0.12 may also be applied with good results to boilers, as 30 pounds of steam per horse-power per hour at 70 pounds pressure represents the average water rate of simple non-condensing engines as well as the quantity furnished by one boiler horse-power.

Example—A power plant consists of

six 100-horse-power boilers which supply steam to four 150-horse-power engines. All of the boilers are to be connected with a main drum or header, from which supply pipes are to be carried to each engine. What should be the size of the boiler leads, the main header, and the supply and exhaust connections with the engines?

The size of the boiler leads equals

$$100 \times 0.12 = 12$$

square inches, which corresponds very closely to a 4-inch pipe. The main header is commonly given a sectional area equal to that of all the leads connecting with it, which in this case would call for

$$600 \times 0.12 = 72$$

square inches, which is slightly less than a 10-inch pipe. To the engines the size of the steam supplies equals

$$150 \times 0.12 = 18$$

square inches; this is somewhat less than the area of a 5-inch pipe, but as 4½ inches is not a standard size, the former would probably be used. The exhaust connections call for

$$150 \times 0.18 = 27$$

square inches, which corresponds to a 6-inch pipe.

In some of the latest high-pressure plants, the pipes leading from the main header to the engines have been made from one to two sizes smaller than called for by the engine builders. These pipes connect with large separators having a cubic capacity about three times that of the high-pressure cylinder and placed close to the throttle-valve of the engine. The connection between the separator and cylinder is made the full size called for by the engine. The object of this arrangement is to have a full supply of steam close to the throttle; to provide a cushion near the engine on which the blow caused by cut-off may be spent, thereby preventing vibrations from being transmitted through the piping system, and, finally to produce a steady and rapid flow of steam in one direction, by having a small pipe leading to the receiver.

When the length of run is over 100 feet, or the main is to supply steam for various purposes which cannot be conveniently expressed in horse-power, it is best to reduce the quantity to be supplied to pounds per minute, and assume a permissible drop in pressure at the end of the line. There are several methods of doing this, among which the following has been used with satisfactory results. This is known as D'Arcy's formula, with certain modifications to adapt it to the flow of steam. This formula in its different forms is given below.

$$Q = c\sqrt{\frac{(p - p_1)\,d^5}{w\,l}}.$$

$$W = c\sqrt{\frac{w\,(p - p)\,d^5}{l}}.$$

$$d = 5\sqrt{\frac{W^2\,l}{c^2\,w\,(p - p_1)}}.$$

$$p - p_1 = \frac{Q^2\,w\,l}{c^2\,d^5}$$

Here

Q = Cubic feet of steam per minute,
W = Weight of steam per minute,
w = Weight of a cubic foot of steam at pressure p,
p = Pressure of steam at inlet to pipe, called the initial pressure,
p_1 = Pressure of steam at outlet of pipe, called the terminal pressure,
d = Diameter of pipe in inches,
l = Length of pipe in feet, and
c = A constant, depending upon the diameter of the pipe.

TABLE 1.

Dia. of Pipe. In.	Value of c.	Dia. of Pipe. In.	Value of c.
1	45.3	5	58.4
1¼	48.2	6	59 5
1½	50.3	7	60.1
2	52.7	8	60.7
2½	54.3	9	61.2
3	56.1	10	61.8
3½	57.1	12	62.1
4	57.8	16	62.6

TABLE 2.

Dia. of Pipe. In.	5th Power.	Dia. of Pipe. In.	5th Power.
1	1.00	5	3.125
1¼	3.05	6	7.776
1½	7.59	7	16,807
2	32.00	8	32,768
2½	97.60	9	59,049
3	243.00	10	100,000
3½	522 90	12	248,832
4	1024.00	16	1,048,756

Table 1 gives the values of c for different diameters of pipe, and Table 2 the fifth powers of the corresponding pipe sizes.

The size of water piping, tables of friction heads, conduits, etc., will be treated of in the next number.

A Troublesome Crank Pin

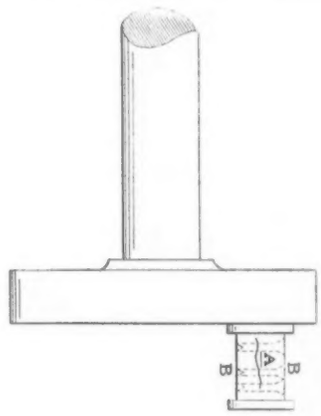
By William Kavanagh

An engineer accepted charge of a plant where considerable difficulty with a crank pin had been encountered, and many engineers had been discharged because they shut the engine down, owing to the heat developed at the crank pin, this closing down of the engine being regarded by the superintendent as unnecessary.

Before accepting the position, the engineer in question gave the proprietors to understand that any serious defects found in the plant would have to be remedied without holding him responsible, as otherwise he would not take charge of the plant. This proposition was agreed to and the plant was started up after an inspection in which the engine received especial attention. After running for a while, the crank pin heated up to a high temperature, but to avoid a shutdown, water was used to keep the crank pin cool until the end of the run.

The first day's experience with the pin was sufficient for the engineer in charge to understand there was something radically wrong, and in order to discover the difficulty the engine-room force was notified to remain until the boxes and pin were inspected and readjusted and a trial run was made. Before the boxes were removed, water was played on the strap pin and boxes to cool them enough to permit handling. Everything was apparently in fine order. The pin was fairly smooth, considering the amount of heating and cooling it had passed through; the brass boxes fitted well; the oilways were deep and well cut, and the chamfering on the boxes was all right. There was no apparent reason why the pin should not run cool unless out of line. Examination showed that the pin was in line, however, and square with the center line of the engine. The boxes were then scraped and replaced and the engine started, after a copious supply of oil had been given the pin.

After a short run the pin again heated. The key was driven back and the run continued, but heat still developed. It was decided to take the boxes off without cooling. This led to the discovery of



the trouble. Upon inspecting the pin while hot, it was found to be split. The defect was impossible of detection when the pin was cooled before inspection, as the cooling caused the crack to close so nearly. The accompanying sketch shows how the pin was split at *A*. Upon the pin becoming heated, it expanded sufficiently to bind in the boxes.

The insertion of a new crank pin would have compelled shutting down the plant, so it was not considered. Three ½-inch holes were drilled through the crank pin perpendicularly to the crack and countersunk, as shown by the dotted lines at *B*. Rivets were fitted to the holes, heated to a bright red, driven into position and upset as quickly as possible. Cold water was applied and the rivets cooled as fast as possible, the object being to allow the contracting effect of the rivets to extend across the split. When the rivets were well driven and cooled, they were filed and finished to the curvature of the pin. The boxes were readjusted and the engine started, with the result that no further annoyance has been experienced from the crank pin heating.

The Three Wire System with Two Dynamos

A Simple Explanation of the Principles Governing the Operation of the Ordinary Edison Three-wire System

BY CECIL P. POOLE

If two dynamos be connected to simple two-wire circuits, as in Fig. 1, they will, of course, operate independently of each other, even if the two circuits be connected at one point of each, as indicated by the dotted line *j*. But if another connection be added at the distributing ends of the circuits, as shown in Fig. 2, the conditions are somewhat changed. As long as the loads on the two circuits are equal, little or no current will flow in the wires *x* and *y* between the dynamos and the lamps. The reason for this will be clear upon comparing Figs. 1 and 2 and remembering that the transfer of electricity is governed by pressures and resistances, very much as in the case of water flow.

In Fig. 1, the current which goes out on the positive wire *w* to the load *a* has no way to get back to the dynamo *A* except through the wire *x*; similarly, the current from the positive brush of the dynamo *B* has no way to get to the load *b* on that circuit except over the wire *y*. But in Fig. 2, the current which passes through the load *a* from the dynamo *A* finds a shorter path across the link *k* than back through the wire *x*, and most of it will go that way. (The load on each circuit is represented by a single circle *a* or *b* in order to localize it and avoid complex distribution conditions. The relative size of the load is indicated by the relative size of the circle.)

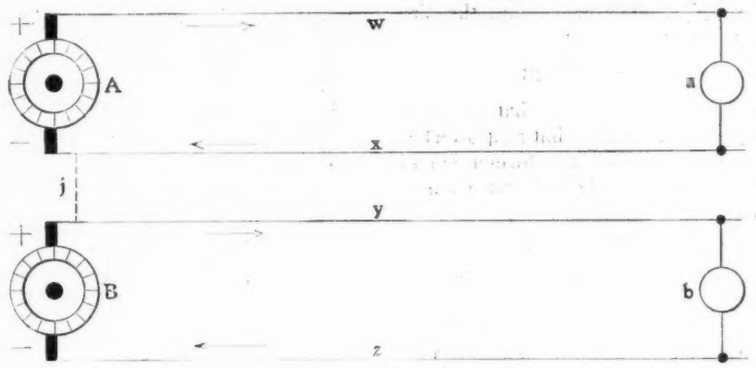


FIG. 1

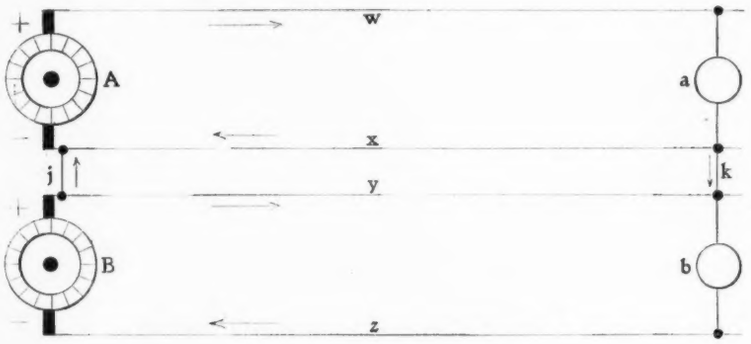


FIG. 2

Now suppose one step more be taken in the combining of the two systems by using only one wire between the junction *j* and the link *k*, as in Fig. 3. So far as the dynamos and their loads are concerned the conditions are exactly the same as before; the only difference is in the flow of current in the circuit. In Fig. 2 a small current flows inward (toward the dynamos) over the wire *x* and a similar current flows outward over the wire *y*, the magnitude of these currents depending on the relative resistances of the wires *x* or *y* and the link *k*. In Fig. 3 no current at all will flow over the wire *n* as long as the loads *a* and *b* are equal. The reason for this is that the e.m.f. of the dynamo *A* tends to send a current inward over the wire *n* and the e.m.f. of the dynamo *B* tends *equally* to send a current outward; these two opposing pressures neutralize each other, and consequently no current flows in the wire *n*.

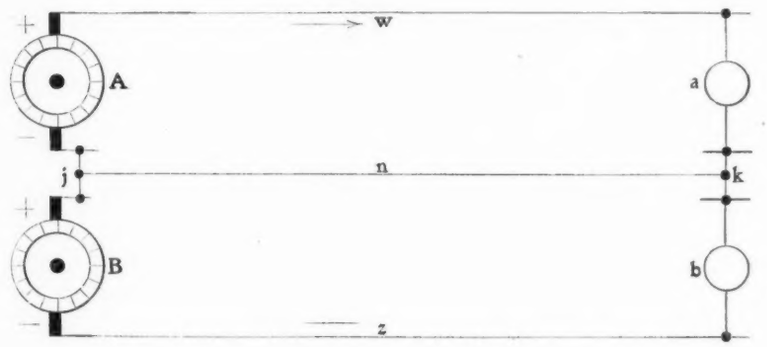


FIG. 3

Now suppose that more load is added at *a* until it is one-fourth greater than the load at *b*; for convenience assume that the load at *a* is 100 amperes and the load at *b* is 80 amperes, as indicated in Fig. 4. Then, the *difference* between the two loads will flow back to the dynamo *A* through the wire *n*, as indicated by the arrows and numbers on the diagram. Conversely, if the load *b* should be greater than the load *a*, the difference between the two loads will also flow through the wire *n*, but this time it will flow outward, as represented in Fig. 5, instead of inward as in Fig. 4. Why? Simply because the sum of all currents of one polarity in any combination of circuits must equal the sum of all currents of the opposite polarity in those circuits, exactly as the combined flow of water through any number of branch pipes must equal the flow of water in the single pipe supplying the branches or taking their combined discharge, as the case may be. In Fig. 4 the two wires *n* and *z* constitute returns for the single wire *w*; in Fig. 5, the wire *z* is the return for the combined currents of the wires *w* and *n*.

The distribution of currents just de-

scribed arbitrarily can, of course, be proved on the basis of the pressures and resistances which cause and oppose their flow. If the reader is ambitious, he can perform the proof without aid by assuming that in Fig. 3 the resistance of each load is 1¼ ohms; in Fig. 4 the resistance of the load *a* is 1 ohm and that of *b* is 1¼ ohms, and in Fig. 5 these are reversed. In all three cases assume each dynamo to give 100 volts and ignore the resistances of the dynamos and the line wires *w*, *n* and *z*; these merely affect the voltage that each dynamo must generate in order to supply the proper voltage at the load—they do not affect the division of currents at all.

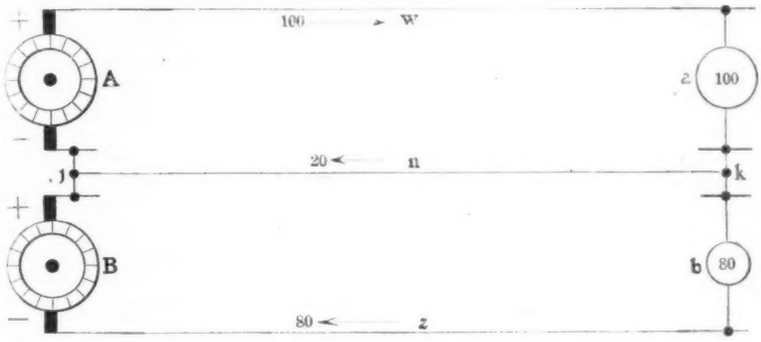


FIG. 4

Since the wire *n* carries current sometimes in one direction and sometimes in the other, it has no fixed polarity, and as the ideal condition is that of equal loads, the aim is to have it carry no current at all; hence it is commonly called the "neutral" wire, or, for brevity, simply "the neutral."

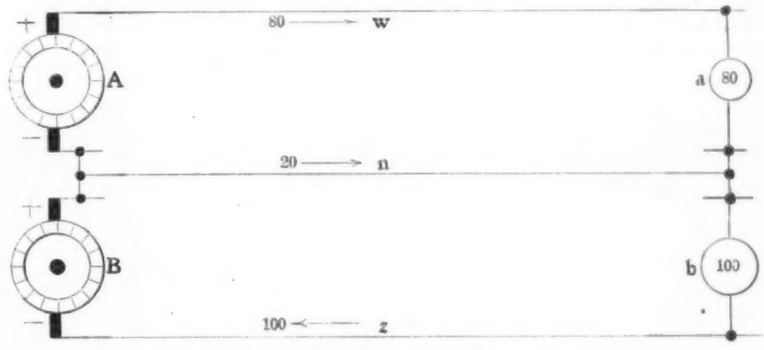


FIG. 5

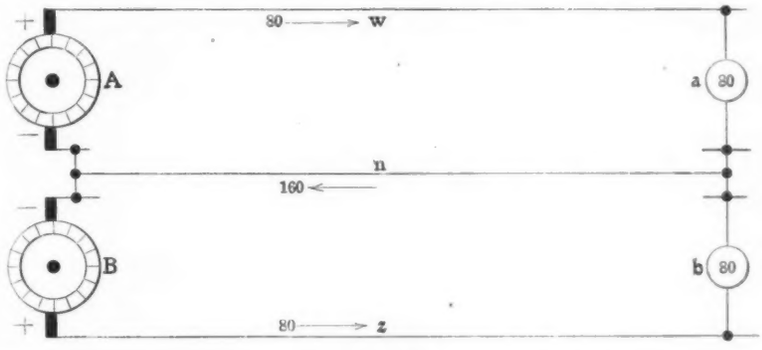


FIG. 6

It occasionally happens that one of the two dynamos of a three-wire system becomes connected to the circuits backward. If the load is distributed between the neutral and the main wires, the only effect will be a reduced voltage at the load, due to the increased loss in the neutral. As Fig. 6 indicates, the current in the neutral wire under such conditions will be equal to the *sum* of the currents in the two main wires instead of their difference, and, therefore, an excessive current will flow in the neutral even when the two loads are equal. If part of the load should be connected directly across from one main wire to the other, without any connection to the neutral, no current will flow through that part of the load, because it will be connected to two wires of the same polarity. In practice it is customary to connect all motors excepting very small ones in this manner, as shown in Fig. 7, where the square *m* represents the motor load and the circles *a* and *b* represent lamp loads. In such cases, of course, the motors must be built for twice the voltage that the lamps are intended to take, because the voltages of the two dynamos are applied in series to the main wires. For example, if the lamps on each side of the neutral require 115 volts each, two of them in series will require 230 volts; hence, the motors connected to the main wires *w* and *z* alone must be built for 230 volts.

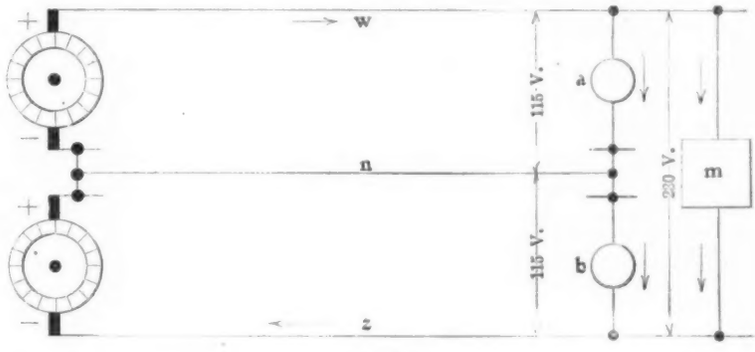


FIG. 7

The two-dynamo three-wire system is extremely flexible in operation. Each dynamo can be adjusted to suit the conditions in its half of the system independently of the other dynamo, and the load in either division can be varied without considering the load in the other division. Of course, the best results are obtained when the two total loads are equal because there is no current in the neutral conductor between the station and the distribution mains, and the loss in the circuits is, therefore, minimum.

It might occur to the reader that if motors can be supplied from the main wires without connecting to the neutral, lamps could be similarly supplied and the neutral conductor left out altogether. The answer to that suggestion is that lamps made for voltages of 200 or over are much less economical than those for the standard pressures of 100 to 125 volts. Moreover, if 200-volt or 250-volt lamps were economical, the three-wire system would be just as advantageous as it is for 100-volt or 125-volt lamps, because the dynamos could then be built for 200 or 250 volts each and the motors for 400 or 500 volts. In short, no matter how

high a voltage it might be practical to make lamps for, it would still be advantageous to use the three-wire system in order to obtain the saving in the cost of line-wires which it confers, whether it were found desirable to operate the motors at double voltage, across the main wires, or not.

The saving due to the use of the three-wire system as compared with the simple two-wire system varies according to the operating conditions and the average distance from the dynamos to the load. If the load is so distributed and of such a character that it can be kept divided almost equally between the two dynamos, the neutral wire can be made very small in comparison with the main wires. On the other hand, if there must at times be much more load on one side of the neutral than on the other, the neutral must be fairly large. In all cases, however, *the size of each main wire of a three-wire system is exactly one-fourth the size of each wire of a two-wire system having the same percentage of loss in the wires.* The neutral wire is the only variable.

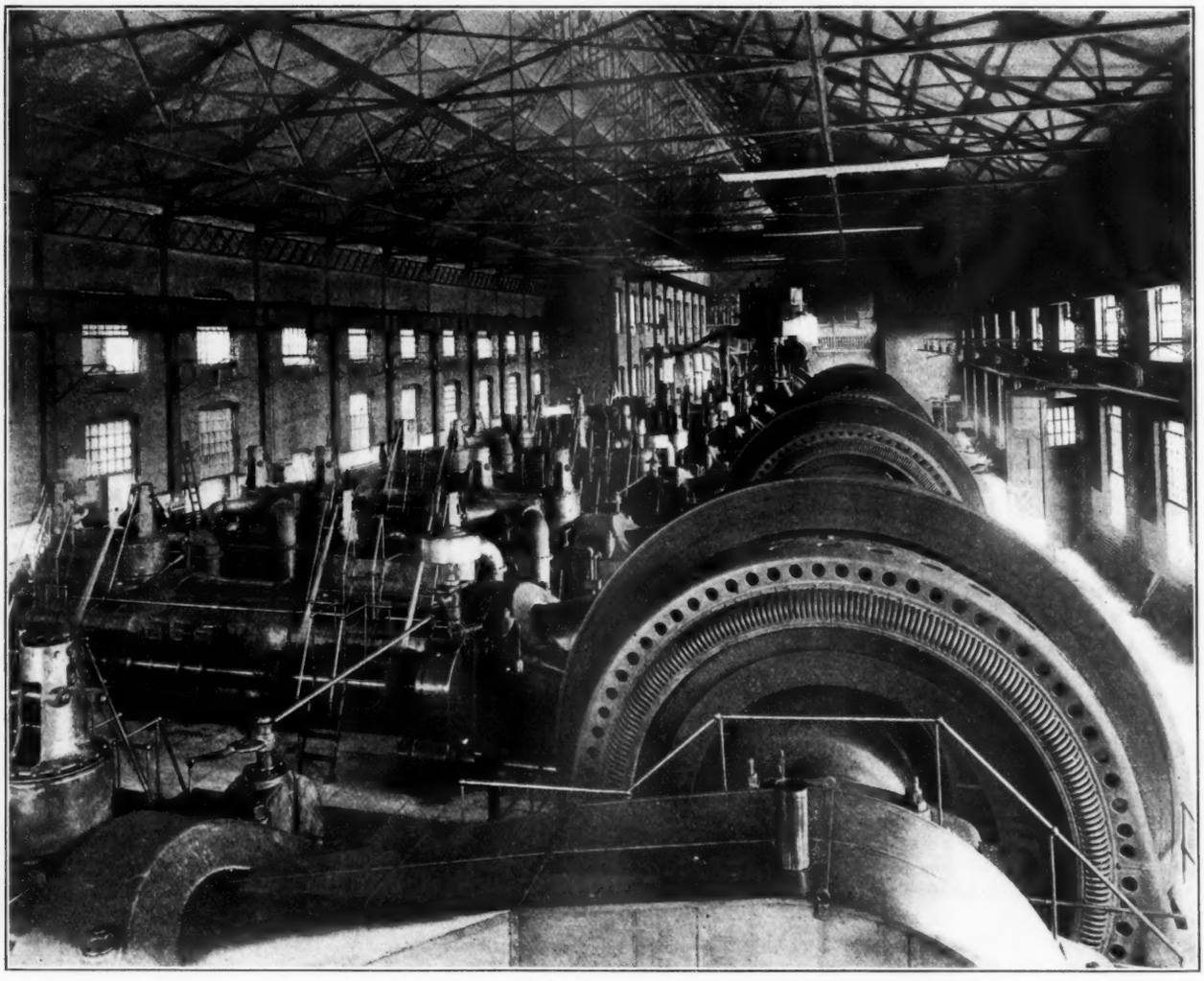
Completion of Gas-engine-driven Electric Generator Installation at the South Works of the Illinois Steel Company

In the issue of August 18 we published a view showing two of the four gas-engine-driven generating units being placed in the South Works of the Illinois Steel Company, at South Chicago. This installation has just been completed, and the photograph reproduced herewith illustrates the entire equipment. The last of the engines is now in operation, and the temporary wall dividing the old power plant from the new has been taken down, throwing it all into one immense station, about half as long as the one at Gary, which contains seventeen such engines.

The generating units, each of 2000 kilowatts normal capacity, are operated in parallel with each other and also with other types of prime movers, including steam turbines. They deliver alternating current at 25 cycles frequency. Part of the generator output is transformed into direct current and used to operate motors in the universal plate mill and elsewhere through the works; the remainder is stepped up from the generator pressure of 2300 volts and transmitted at high potential to the mills of the Universal Portland Cement Company, at Buffington, Ind., where the slag from the Illinois Steel Company's furnaces is made into cement.

The engines and generators, as fast as installed, have been subjected to continuous (24-hour) service at heavy overloads and at present are delivering about 2600 kilowatts each, thereby adding to the score for reliability of gas-engine-driven electrical units.

There are water powers within transmission distance of most of the large American cities, according to H. von Schon, speaking at the last meeting of the Western Society of Engineers, to meet all present power requirements, if proper provision were made for storing the water.



ALLIS-CHALMERS TWIN TANDEM GAS ENGINES IN THE POWER PLANT OF THE ILLINOIS STEEL COMPANY AT SOUTH CHICAGO

A Practical Consideration of Gaskets*

Essentials of a Good Gasket, Qualifications of the Various Sheet Packings in General Use, and the Proper Method of Cutting Gaskets

BY W. E. SANDERS

The theory of the gasket is quite simple. It is necessary to prevent a fluid or gas from leaking out between two surfaces that are both stationary. This is a much easier proposition than when one of the surfaces is in motion, as is the case with rod packing. A gasket prevents leakage, partly by its own strength and partly by its grip of adhesion to the flanges. The necessity for strength in the gasket itself is clearly shown by an illustration. In blowing up a toy balloon the harder you blow into the balloon the more the rubber is stretched, and the balloon will break when the strength of the rubber is overcome. In the simplest form of gasket, that which is used in a pipe line, this principle is clearly shown. As the pressure from within forces the gasket outward, it tends to stretch the gasket, making it of a larger circumference, and if the gasket is not strong enough, it will break. Tensile strength then is one of the essential characteristics of a good gasket.

The second element of efficiency in a gasket is its ability to grip the flange, or to stick to the flange. In ordinary cases this depends chiefly on the structure of the flange, and the packing is therefore independent of this feature. A rough flange is bad, because it allows a chance for an inequality in thickness of the gasket when it has been set up in position, and will cause a weak place where the gasket is squeezed down thin. A faced flange is not perfectly smooth and affords enough roughness to grip the packing satisfactorily, although the roughness may be scarcely perceptible to the hand.

In extreme cases flanges are sometimes packed with sal ammoniac, which rusts the flanges together and is an example of the packing in which there is no tensile strength, everything depending upon the grip or adhesion; in fact, the two flanges are packed with a coating of rust caused by this sal ammoniac. On the other hand, the use of a metal gasket is a case where the dependence is placed almost entirely on the strength of the gasket, there being no real adhesion of the gasket to the flange. It is customary in ordinary gasket practice to coat the gasket with pipe paste or graphite, which, when mixed with cylinder oil, is easy to apply. In such a case the graphite acts as the parting sand used in a foundry, and makes it possible to break the joint without destroying the gasket. Strictly speaking, the use of this graphite prevents adhesion, but the gain in cost of new gaskets overcomes the loss due to lack of adhesion. Sometimes a gasket is graphited on one side only. This is a matter of convenience and has no bearing on the strength of the gasket.

There are other characteristics, more practical than theoretical, which must be taken into consideration. If the gasket is to be used on a pipe line where there is much vibration, it is necessary to have a gasket that is more or less elastic, and at the same time of sufficient density. A great many packings are sold in which cheap rubber substitutes are employed, giving a gasket which apparently is very elastic to compression. The difficulty lies in the fact that when steam is turned into the main and the gasket becomes warm, the materials of the gasket will soften and there will be a tendency toward "melting" and running out. This gasket must be "followed up." The softer the gasket the more quickly and the more must it be followed. If the steam is turned on full pressure, it is liable to blow out at the start. In this case steam should be applied with only a few pounds pressure until the gasket is thoroughly heated, and then the gasket should be followed up before full pressure is applied.

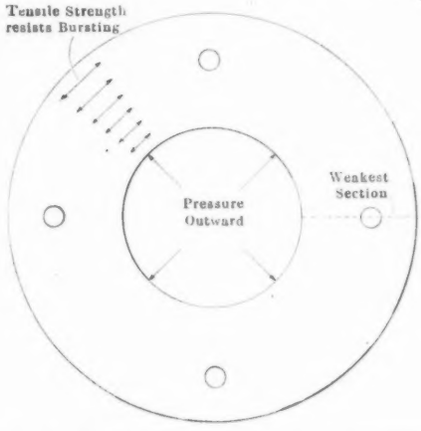


FIG. 1. RESULTANT STRESSES IN A GASKET

It is thus clear that the thinner the gasket the better. In fact no gasket at all is the best, i.e., a ground joint; but ground joints are expensive. Next to the ground joint the use of red or white lead between well faced flanges is to be preferred, and after this sheet packing, which should be as thin as possible. In the manufacture of packing 1/32 inch thick there are difficulties which make it desirable for a manufacturer to produce packing at least 1/16 inch in thickness. For convenience of carrying in stock by dealers the 1/16-inch packing is satisfactory, and 99 per cent. of the joints require nothing over this thickness. Some engineers use 3/32 inch and ⅛ inch, or even thicker, but this is bad practice for ordinary conditions, and there is more liability of blowing out than where the 1/16-inch packing is used. On valve-chest covers, or cases where there is no vibration, it is not necessary to have much elasticity, and a packing can be employed which will conform to the surface, but need not necessarily have any appreciable elasticity. The essentials then, of good gasket packing are tensile strength and density and ability to grip the flange.

Cloth-insertion Sheet Packing

This is the simplest sheet packing, and probably originated in a compound of rubber. When it was found that this lacked tensile strength, a strip of cloth was placed inside of the rubber, giving cloth-insertion packing. The cloth gives the tensile strength and the rubber furnishes the adhesion to the flange and permits the gasket to adjust itself to any unevenness in surface. This packing may be made with cloth inside and rubber compound on both outsides, or it may have cloth on one side, or cloth on both sides, and is known as C. I., C. O. S. or C. B. S. sheet packing.

Competition among manufacturers has been so keen that the compounds now used have little or no gum in them. In fact, they are made so cheaply that it would be impossible to use anything but substitutes. This packing is good for ordinary conditions. Where made with better materials it will do for average mill and power-house work, but for high pressures or high temperatures it should not be used. It can be used over again by graphiting one side only.

Red Sheet Packing

Probably the largest amount of packing used is of the red sheet variety. The best of these packings are those which have the greatest tensile strength and density. All of them have elasticity, but those which can be easily indented with the thumb nail are liable to have a large quantity of rubber substitute and

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will melt easily, requiring more "following up."

Another point to be considered is the cure of the packing. If the packing is properly cured, fresh good surfaces will not stick to each other, nor have any stickiness or tack. If it is undercured, it will not only have this stickiness or tack, but will not have a high tensile strength. If it is overcured, it will crack easily when bent double on itself. Very often this overcuring is only on the surface and is not a fatal defect, although it is better if it is cured to just the right point. This overcuring on the surface is found more frequently in a press-cured packing with a smooth surface. Where the surface is slightly roughened and shows the imprint of the cloth liner used during vulcanization, the packing is less liable to be overcured on the surface.

It will be found that in time this packing may change color, and a fine dust will appear on the surface. This dust is the sulphur which, having been used to vulcanize the rubber, gradually works its way to the surface. This bloom does not impair the packing at all, and if anything, is a favorable sign. If the packing is cured properly, it will not bear keeping in stock for a long time. Age and warm air will sooner or later cause it to harden slightly so that it will crack easily. Frequently a roll which has been left standing for a year or so will show this hardness on the edges. It is not necessary to throw aside the entire roll, but if the edges are cut off, the inside will probably be found to be in first-class condition. It is the practice of some manufacturers to slightly undercure the packing so that it will not age for a number of years. This is all right as a preventative to aging, but gaskets cut from such packing have not the same strength and do not last as well as gaskets cut from packing which is thoroughly cured.

Competition in sheet packings, particularly in red sheet packing, has brought it about so that the purchaser gets just what he pays for. In other words, the quality of the packing can often be gaged by the price charged for it. The cheaper red sheet packings have a large amount of substitute rubber and comparatively little organic matter, are easily indented by the thumb, and while they will stretch a good deal, have not a very great tensile strength. The highest priced red sheet packings are quite dense, are not easily indented with the thumb nail, and have a high tensile strength with little stretch. It is a safe proposition to avoid the cheap red sheet. There are a number of rubber packings which are similar to the red sheet just described, but which vary merely in color. These colors are white, different shades of red, and sometimes blue, but all belong in the class of red sheet packings.

Semi-vulcanized Sheet Packing

There is another class of pure packing which is purposely semi-vulcanized. This packing is generally black and contains a large amount of inorganic matter. It will become very soft when heated. Sometimes this is an advantage in cutting gaskets, for when soft it can be bent to fit any shape, and a large gasket can thus be cut out of a narrow sheet. Its advantage lies in the fact that it will adhere to the flange and then become hard. So tightly will it cling that it is generally necessary to use a cold chisel in removing an old gasket. The sticking to the flange can be overcome by the use of graphite. This packing has no elasticity and therefore should not be used wherever there may be vibration.

When the packing is applied, the steam should be turned on to only a few pounds pressure, and then after the packing has been thoroughly warmed, it should be followed up and allowed to cool. The heat softens the packing, but when it is cool it

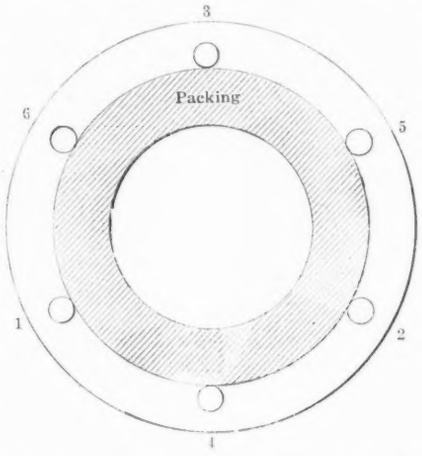


FIG. 2. PROPER METHOD OF CUTTING GASKET AND ORDER OF DRAWING UP BOLTS

hardens and becomes set. After it is cool, steam can be turned on to full pressure with freedom. Some engineers find it quicker to throw a bucket of water over the warm flange and cool it much more rapidly than if it were allowed to cool down in the natural way. The result is about the same, whether it is cooled quickly or slowly.

The scrap or waste from this packing can be worked over by the manufacturers, and as a rule they will repurchase it at a satisfactory price. In this respect the packing is economical, since there need be no waste. This self-vulcanizing packing is good for use on permanent joints, or joints which have no vibration. If the joint has to be broken at all, it is best to graphite one side only and leave the other side to stick to the flange, which it will do very tightly.

Oilproof Sheet Packing

Sometime ago there came from Germany a black, glossy sheet packing which has a high tensile strength and which resists particularly the action of oil, and is known as an oilproof packing. The original German packing was very light. It does not come in rolls, as do the packings made in America, but comes in sheets a yard wide and two to three yards long. It is high priced, and there is a great deal of waste. On the other hand, it is very light, and since it is bought by the pound, the cost is not what the high pound price would indicate. At the same time it is so much higher than American packings that it is not used to any very great extent, in spite of its excellent qualities. Its resistance to the action of oil makes it impossible for lubricating oil, which is passing through the pipes, to affect it or eat it away.

As oil is the greatest enemy to rubber, there are times when an oilproof packing is very necessary. The American packings, which imitate this original German packing, are made in rolls and some of them are very good imitations, both as to finish and also as to oil-resisting qualities. In this packing, as in red sheet packings, you get what you pay for. If a good price is paid, a good packing will be obtained, but if a cheap packing is bought, it will be found that it not only lacks strength, but is easily attacked by oil, although it is supposed to be oilproof.

Wire Insertion Sheet Packing

Gaskets are strengthened for use in severe cases by using a wire insertion. This insertion is sometimes made of annealed iron wire, but as the iron is liable to rust, it is preferable to avoid its use. Generally the insertion is of brass wire. Only one ply is used, irrespective of the thickness. The cheaper grades will use a wire of about 28 Brown & Sharpe gage and 12 or 14 mesh. Really this is too wide a mesh, and the Government specification calling for 28 Brown & Sharpe gage wire and 24 meshes to the inch is about right. The packing on the two sides of the wire cloth should join together through the mesh.

Lead wire is sometimes used, but unless there are reasons which make it necessary to avoid the use of brass, there is no particular advantage in the use of lead wire, and it only adds to the weight and resultant cost of the packing. Wire-insertion packing gives a gasket that is particularly serviceable under hard conditions. The waste, however, cannot be used in any way, and for ordinary purposes it is not necessary. If an insertion is to be used, cloth will usually be perfectly satisfactory.

It has been the custom with some erecting engineers to use a gasket made of a very thin, tough paper soaked in oil. Where the surfaces are very well faced, this is often satisfactory. There is no adaptability to the surface, however, in this packing, and ordinarily it will not do the work well. Lately there has appeared on the market a packing of this

nature, which is really a very tough paper made of parchment fiber. It is absolutely impervious to water, but when used on steam pressures of over 100 pounds, is liable to carbonize and has to be replaced.

Asbestos Sheet Packing

Rubber and rubber compounds and cloth are all organic and cannot stand high temperatures. When it is necessary to pack high steam pressures or steam that is highly superheated, organic compounds will not do, since they will char or burn up. To get around this an inorganic compound, asbestos, is used. This is a mineral fiber, and when crushed, separates into fibers which may be spun into threads and woven into cloth. Asbestos will stand the heat satisfactorily, but will not stand moisture, as water will soak up between the fibers, just as it will in a piece of blotting paper, and when it separates the fibers, they lose their grip on each other and the fabric becomes weak. To protect it, the cloth is covered with a compound which prevents the moisture from coming in contact with the asbestos. Sooner or later this covering will harden, but as it hardens in position, it still protects the asbestos.

To gain the tensile strength necessary, the threads are often spun with a fine brass wire. Cloth that is constructed in this way has a high tensile strength. The best commercial asbestos is obtained from Canada and has a long fiber. So great has been the demand for asbestos packing that there has been a tendency to use shorter fibers in the filling of the cloth, that is to say, the threads in one direction will be made of the long fiber and the threads in the other direction will contain the short fiber. Asbestos cloth made in this way will tear easily in one direction, but cannot be torn, without great difficulty, in the other direction. This can easily be tested before purchasing. It is very hard to tell just the quality or amount of asbestos in the packing. A certain amount of cotton, generally about 10 per cent., is used in the spinning, and is necessary. A larger amount is an adulteration and is used in the poorer and cheaper grades. It is usually made and almost always used in 1/16-inch thickness. For very close work it is made 1/32 inch thick. It is very seldom used in thicknesses over 1/16 inch, and there is really no advantage in a thicker size.

Gaskets are now being made of this wire insertion asbestos sheet and are known as "folded asbestos gaskets." The gasket so made is folded in on itself twice, making a four-ply gasket. As the gasket is folded in, the splice is wrapped in on itself, giving just the same grip that is obtained when two ends of a rope are spliced.

Sometimes these gaskets stiffen up in service, particularly when used on boilers, but if they are submerged in kerosene for an hour or so, they will regain their pliability. These gaskets are sometimes made without a seam, but as the splice of the ordinary gasket is scarcely visible, and as the gaskets are as strong at the splice as in the body, there is no particular gain in using a seamless folded asbestos gasket, although at first glance it would seem as though it ought to be stronger. The gaskets made for headers on water-tube boilers are generally two-ply in thickness. They work fully as well as the four-ply, and, in fact, better.

Fiber Sheet Packing

There is another class of packing, brought over from Germany a few years ago, which now has a number of American manufacturers. The original German packing is made in sheets of about one yard wide and two yards long. It is made of asbestos fiber and rubber or gutta percha with more or less inorganic material, and, when being manufactured, is compressed under high pressure. Its tensile strength is very high, its elasticity is slight and its resistance to high temperature is good. It is growing in favor in a great many places, but it has not been in service long enough to permit of a final judgment. There is a great deal of waste

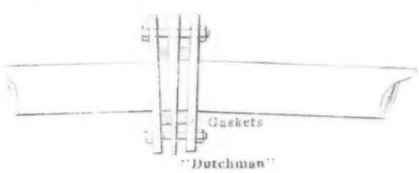


FIG. 3. ONE OF THE PLACES FOR A "DUTCHMAN"

in this packing. As it is not made up in the form of cloth, it can in some respects be cut more easily than an asbestos cloth. The American imitations are for the most part cheaper in quality as well as in price. Some of them are excellent, but many of them are inferior. The original German packing is grayish in color, and the imitations run in gray, red, brown, black and mottled.

Cutting Gaskets

In choosing a sheet packing, attention should first be paid to the condition of service. If the joint is in a line subject to vibration, or contraction and expansion, a packing should be used which has some elasticity. If there is no vibration, a packing can be used that is inelastic and more or less permanent. If there is much pressure, tensile strength is the deciding factor. If there is little pressure, a packing that has little tensile strength can be used. If the temperature runs high, attention must be paid to the density of the packing so as to avoid unnecessary following up. If the temperature is very high, it is necessary to use a packing which will not be affected by heat, such as asbestos packings or the fiber packings last mentioned. If the joint is to be broken, graphite must be used so that there will be an easy parting between the gasket and the flange; otherwise the gasket will almost certainly be torn when the joint is first taken apart.

Great care should be taken in cutting gaskets. The old shop method is to lay the packing over the flange and cut it with the hammer. This is really tearing the gasket and leaves a ragged edge. It will be noticed that a packing salesman will always submit a sample of packing with a fresh-cut edge, because, if there be any break in the edge, it will start to tear very easily. To give a gasket the best chance possible, the gasket should be clean cut with a knife, so that there will be no opportunity for a tear to start. If there is a nick or cut in the edge, there is a chance of the gasket giving way very soon at that point.

When cutting a gasket for a pipe line, and in fact for almost all other cases, the gasket should not extend around the bolts. There are two reasons for this: First, the strength of the gasket depends on the section running through the bolt, and the additional thickness of gasket which lies beyond the bolt hole is not of any particular value. If the gasket is cut to fit inside the bolt holes, less packing is used and an economy is effected. More than this, it is much easier to insert a gasket of this sort than one in which bolt holes have been punched. A description of the operation of putting in a gasket will make this clear.

The ends of the pipe are supported; the bolts are loosened; small shims or wedges are driven in on opposite sides, and the flanges are thoroughly cleaned with a scraper or file. The lower bolts are put loosely into position and the gasket is dropped in by means of a thread from the top until it rests on these bolts. The other bolts are now placed into position and the wedges are withdrawn. If bolt holes were punched out, there would be considerable difficulty and time lost in getting the bolts to go properly through the gasket.

When the gasket is in position, do not draw up the bolts tightly, but draw up one with the thumb and finger; then draw up the one opposite that; then draw up the one on the quarter and the one opposite that and so on until all have been drawn up with the thumb and finger only. Then use a wrench to draw the bolts up more tightly, but in the same order as at first. Never draw the bolts up tightly on one side with the other side loose, because the gasket will be squeezed on one side, forcing it more or less over on the other side and introducing internal stresses which will weaken the gasket. A man who has had experience in inserting gaskets can very easily put in a gasket so that it is almost absolutely certain that it will blow out. On the other hand, he can take packing which is comparatively poor, and by putting the gasket in prop-

erly and drawing it up with care, make it last for a long time.

When the flanges do not come squarely together a "dutchman" is sometimes used. This is nothing more or less than a piece of wedge-shaped metal, the thicker portion being on the side where the flanges are farthest apart. Regular gaskets are used on both sides of this, and a good joint can be made in this manner. It is better, of course, to change the hanger so as to bring the pipe in line and avoid the use of a dutchman. Sometimes it may be necessary to remove the flange and put on a new flange. The pipes should never be forced together, because, no matter how carefully this is done, the strain will always be greater on one side than on the other, and the gasket is almost certain to blow out.

Cleaning Babcock and Wilcox Boilers

By Percival Hastings

Although boilers of the Babcock & Wilcox type are in service all over the United States, there is doubtless a large number of engineers who are not familiar with them. This lack of experience makes the work of cleaning tedious and uncertain, so that a few words on the subject will perhaps facilitate matters.

Upon laying a boiler up for cleaning, the first task should be to clean out the combustion chambers and the dust off the tubes and caps. While the boiler is under steam the tubes have to be blown through the opening provided in the brickwork at the side. This method does not remove all of the soot, so that as soon as the boiler is cool enough, the fireman should enter each compartment and from his position on top of the tubes push the steam-hose nozzle down between each row. A tee or elbow placed on the end of a ¾-inch pipe will enable him to direct the steam into all corners until every tube, cap and all heating surfaces have been well cleaned. Next examine the grates, lining and dampers and note what repairs will be necessary, if any.

Work can now be started on the inside of the boiler. Open the blowcock and let the water down below the level of the drums, take off the manhole plates on each end and flush out the drums, using a 2-inch hose if such a connection can be obtained. Next examine the plates, note the thickness of scale, look for signs of pitting or oil, scrape all scale and thoroughly clean. If any pitting has occurred, paint the spots affected with white-lead paint, and after they are dry, give the drum a light coat of paint up to a point a little above the usual water line.

Now let the rest of the water out of the boiler and take the caps off back and front. Two or three half-barrels filled with water should be at hand, and as the caps are taken off, place caps and nuts into one barrel and safety plates and bolts into another. This is done to keep the scale soft. A little kerosene oil added to the water will sometimes help to soften the scale. It does not pay to clean the tubes with a hand scraper, so we will assume that a turbine cleaner is provided. The work of putting the cleaner through the tubes should be started before they have had time to dry out. If the scale is heavy, two different sets of cutters will be used, but where the scale is only 1/16 or even ⅛ inch thick and not hard, the finishing cutter can be used. The cock controlling the water pressure should be placed where the operator can reach it from the scaffold in front of the boiler. Once the turbine is started, it should be pushed slowly through the tube. If for any reason the turbine is stopped feeding through the tube, shut off the power. To leave the cutters revolving steadily in one spot might injure the tube. The pressure carried and time taken to each tube are governed by the condition of the scale. It is possible to clean an 18-foot, 4-inch tube in three minutes, where the scale does not exceed ⅛ inch.

Some means must be provided to carry the water away from the back connections. If this cannot be done, the back caps can be left on until the tubes are cleaned, care being taken not to strike the plates with the turbine cutters. While this work is being done, if there is help enough, scrape the scale off the caps, plates and bolts, and let them dry. It will be necessary to polish the face and back of the caps, also the nuts. If there is a line of shafting near the fireroom, rig up a countershaft on a bench and place a 12-inch wood pulley on the end; cover the end of the pulley with a piece of pine, and on this fasten a sheet of No. 1 emery cloth with a few thumb tacks. This wheel should revolve about 500 revolutions per minute. If a ¼- or ½-horsepower motor is available, a wooden faceplate can be fastened onto the pulley, care being token to balance it, running at a speed of 800 revolutions per minute. A cap can be polished in about 30 seconds. Care must be taken to hold caps and nuts square and flat on the wheel. As each cap is finished the polished surface should be wiped with an oily rag or waste to prevent it from rusting.

The tubes and headers being scaled, the headers can now be polished. A handy way of doing this is to cut out a wooden circle just large enough to fit inside the opening of the header, cut another 1½ inches larger; on this place a piece of No. 1 emery, place the smaller piece in the center of this and through the center bore a ⅜-inch hole. Put a bolt through this long enough to project 2 inches, run a nut and washer down and clamp the two pieces together and file the end of the bolt so that it can be inserted into the chuck of a hand brace. A dozen revolutions or so in each tube opening on the header will clean and polish. We are now ready to replace the caps. If a good tight job with no leaks is wanted, the following method must be closely observed:

First see that the dust is kept brushed off the headers, as the work progresses. Boiled linseed oil and a little graphite should be used on the caps and ground surfaces of the nuts. A little graphite on the bolt threads will be better than oil; the graphite can be brushed on the bolt while it is in the hands of the cleaner. In placing the caps on, two men can work to better advantage than one. Let one man brush off the cap and nut with graphite and boiled oil, slip the bolt through the safety plate and cap, and screw on the nut about two threads. In this shape they should be handed to the man who is to place them in position. He should receive the plate in his left hand with the cap resting on the nut, catch the nut with the right hand and with the left lift the plate into the header. The plate should not lay crosswise in the header, but should lay with the contour of the header. The plate being in position, screw up the nut hand tight and see that the cap rests evenly. Give it a slight twisting motion to make sure of seating it, and then tighten just enough to hold it in position. In this manner the writer has put on 144 caps in two hours. After they are all on, tighten them up with a cap wrench with a handle about 2 feet 6 inches long, and only one man on the wrench. Right here it may be said that it does not require the strength of two men to make a tight joint, and it is an easy matter to split a cap by using too much muscle. It must be remembered that you are dealing with ground joints, with no packing to pull upon.

After the caps and manhole plates are on, fill the boiler with hot water, and with a piece of chalk mark any caps that may leak. If no bad leaks are found, pump up a pressure of from 50 to 100 pounds, and inspect all caps and joints carefully. Mark all leaks, let the pressure off and then on the leaky cap slack off the nut a little, but not enough to loosen the cap; strike the cap and tap it sideways back and forth once or twice, or give it a slight twist, and then tighten it again. This method in most cases will result in a tight joint and save the trouble and waste of emptying the boiler. It must be remembered that one little piece of grit between the cap and the header will cause it to leak. Therefore, exercise great care while handling the caps and keep the oil pot and brush covered when they are not actually in use. When a boiler is allowed to remain in service with leaky caps, the action of the escaping water will groove both the cap and header.

Trouble is sometimes experienced from leakage of the mud-drum nipples. If after re-rolling or expanding the nipple still leaks, it is safer to cut it out and re-

place with a new one. A good many engineers are under the impression that the mud drum rests on the brickwork in the back connection chamber. This, however, is not the case, and the space varying from 1 to 3 inches underneath should be cleaned out along with the rest of the ashes. When a mud drum shows signs of scale or rust on the outside, it should be well scraped and given a coat of graphite paint or smokestack varnish, including the nipples. The writer is opposed to the use of compounds to keep the scale off boilers, and advises engineers to get the scale-forming properties out of the feed water before it enters the boiler. If, however, the proper apparatus cannot be secured and a scale solvent is really required, have the water analyzed so that the proper neutralizing agents can be employed.

Cleaning boilers is not an ideal occupation. Study up the plant and see what can be done to keep the scale-forming matter from getting into the boiler. A good feed-water heater with a surface blow is a valuable asset, providing it is looked after.

Hangers and Supports for Piping Systems

By William S. Fischer

Where it is required to suspend a line of piping from the floor or roof beams overhead, the hanger shown in Fig. 1 is best suited to the purpose, providing there is sufficient room (see dimension *O*) between the under side of the beam and the center of the pipe to accommodate the beam clamp, pipe clamp, turnbuckle and rods, as shown. It is a good plan to make the rods *R* with upset screw ends, making the area at the root of the thread greater than the area of the rod. The upset ends, with round or square shanks, as desired, are furnished with the turnbuckles, if so specified when ordering. One is to have a right-hand screw thread and the other a left-hand thread, and when making up the hanger, they may be welded to the rods to suit the dimension *O*.

TABLE 1. STANDARD I-BEAM CLAMPS.

Size Beam.	Dimensions.			
	A	B	C	D
3	2⅜	¾	½	1
4	2¾	⅞	9/16	1¼
5	3	1	¼	1½
6	3⅜	1¼	¼	1¾
7	3¾	1½	¼	2
8	4	1½	¼	2¼
9	4⅜	1⅝	5/16	2½
10	4¾	1⅝	5/16	2¾
12	5	1⅝	⅜	2¾
15	5½	2	⅜	2¾
18	6	2⅛	½	3
20	6½	2⅛	½	3

All dimensions in inches. See Fig. 1.

With this arrangement the rods extend or stretch evenly along their entire length, whereas if the rod itself is threaded, the area at the root of the thread will necessarily be much less than the area of the rod. Consequently, all the extension occurs in the short length at the bottom of the threads, and the threaded portion breaks before the rod has even passed the elastic limit.

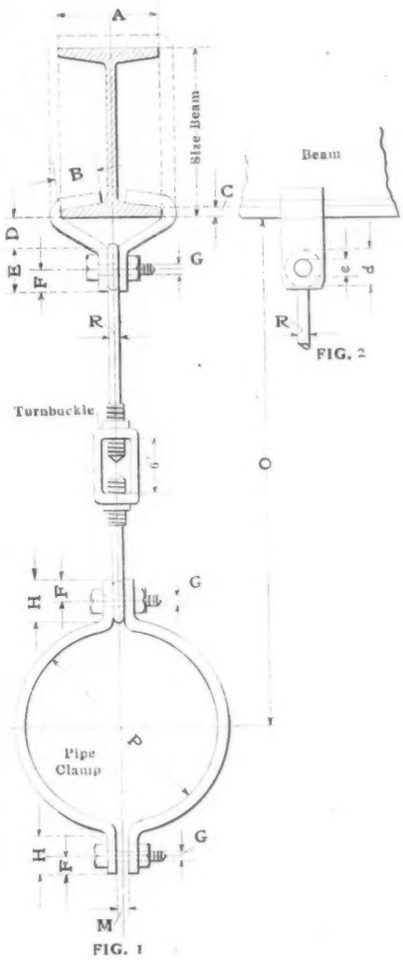


FIG. 1

FIG. 2

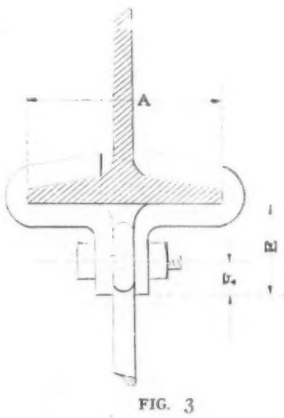


FIG. 3

Many concerns, however, prefer using the plain rods with threaded ends in place of the upset ends here shown, as the weld, if not carefully made, is the first point to give out in the hanger. If this method is preferred the rods should be at least ⅛ inch greater in diameter than shown in Table 2, in the column headed *R*.

The dimensions *A*, *B*, *C* and *D*, Fig. 1, are fixed by the size of I-beams from which the pipe is to be suspended. The dimensions in Table 1 are for standard I-beams from 3 to 24 inches inclusive. All other dimensions are determined by the size and weight of piping to be suspended. The dimension *P* should equal the outside diameter of the pipe, valve or fitting to be clamped, according to the position of the clamp. For ordinary steam, exhaust, air or vapor lines, the dimensions given in Table 2 are well on the safe side for strength and stiffness. For extra heavy cast-iron water mains and similar heavy pipe, the dimensions should be slightly increased according to the size and weight of the piping used.

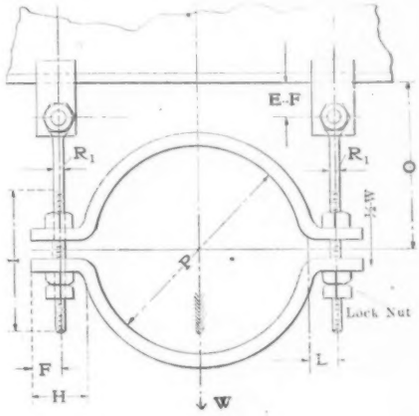


FIG. 4

Hangers should be spaced about 12 feet apart, as a general rule, and where three or more heavy fittings and valves are placed close together in the line, one or two extra hangers should be used to prevent sagging and to take the strain off the flanges and joints.

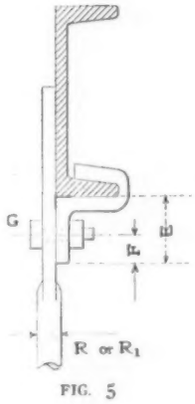


FIG. 5

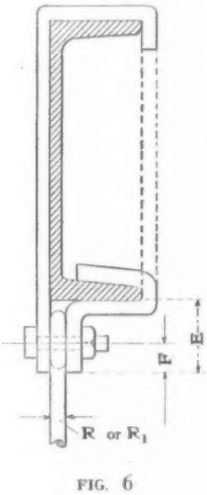


FIG. 6

Fig. 2 is a side view of the beam clamp shown in Fig. 1, giving the dimensions of the eyebolt and drilling for bolt *G*. In Fig. 3 is shown another form of I-beam clamp. The disadvantage of this is, that it cannot be adjusted in the field as easily as the form shown in Fig. 1 in case of any variation in the width of the flange *A*.

TABLE 2. STANDARD PIPE HANGERS.

Size of Pipe.	Size of Iron in Beam Clamp.	Size of Iron in Pipe Clamp.	Diameter of Rod.	Size of Turnbuckle.	Diameter Outside of Eye-Bolt.	Diameter of Hole for Bolt.					Diameter of Bolt.
			R		*d*	*e*	*E*	*F*	*H*	*m*	*G*
1½ to 3	¼ x 2	¼ x 2	⅜	⅞	⅞	2⅛	2½	⅞	2	½	⅜
3½ to 5	⅜ x 2½	¼ x 2½	½	1	1	2⅜	2½	1	2½	¾	½
6 to 8	½ x 2½	⅜ x 2½	⅝	1¼	1¼	2⅝	3	1¼	2¾	1	¾
9 to 14	½ x 2½	½ x 2½	1	1⅜	1½	3⅛	3½	1½	2¾	1	1⅛
16 to 20	¾ x 3	½ x 3	1¼	1½	1⅝	3⅝	3½	1⅝	3	1	1¼
22 to 30	⅞ x 3	⅝ x 3	1½	1⅝	1⅝	4⅛	4½	1⅝	3½	1	1½

All dimensions in inches. See Fig. 1.

Owing to the short grip (dimension *B*) on beam clamps, for beams up to 6 inches in size, it is desirable to carry the clamp over the top of the I-beam, as shown by the dotted lines in Fig. 1. In some cases this may not be possible owing to the position of the beams.

Where there is insufficient head room for the type of hanger shown in Fig. 1, the hanger shown in Fig. 4 may be used. Here there are two rods and two beam clamps supporting the load, so that their proportions, as given in Table 2, may be reduced accordingly. The lower pipe saddle should be increased in thickness, however, as there is a bending moment, $\frac{1}{2} W \times L$, at its outer edge. The upper pipe bend is not absolutely necessary, as it plays no part in the support of the pipe and may be omitted or not according to the judgment of the designer.

In Table 3 are given satisfactory dimensions for hangers of the type shown in Fig. 4. All the other dimensions not given in Table 3 are the same as Tables 1 and 2. The rods R_1 should be threaded on the ends from 6 to 9 inches for convenience in adjusting the position of the piping.

Fig. 5 shows a method very often adopted for clamping to a channel beam. The rod *R* is welded to the flat piece directly above it. With this arrangement the total load is supported by the single clamp to the right. The bolt *G* is in single shear, and unless made of heavy

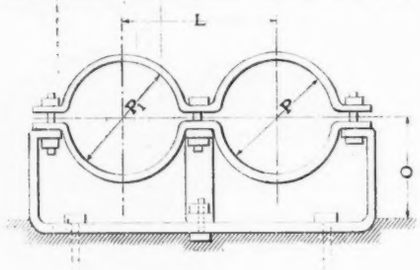


FIG. 7

iron, the clamp is liable to bend, causing a sag in the pipe line at this point. The arrangement shown in Fig. 6 is to be preferred. The bolt is double shear, and the whole clamp is much more rigid than the one shown in Fig. 5. The clamp may be made in one piece, if preferred, as shown by the dotted lines.

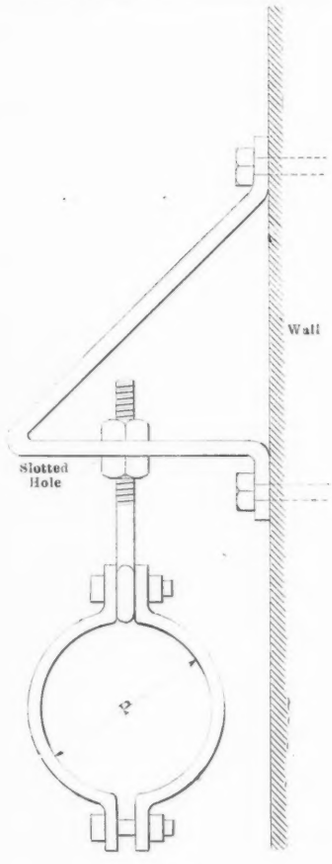


FIG. 8

Fig. 7 shows a form of pipe support which may be made up of wrought iron for one or more pipes where run above the floor line. This is made much easier and quicker than a casting, and in most cases answers the purpose equally as well.

TABLE 3. STANDARD PIPE HANGERS.

Size of Pipe.	Size of Iron in Beam Clamp.	Size of Iron in Lower Pipe Saddle.	Size of Iron in Upper Pipe Band.	Diameter of Rod R_1.
1½ to 3	¼ x 2	¼ x 2	¼ x 2	⅜
3½ to 5	¼ x 2	¼ x 2	¼ x 2	⅜
6 to 8	⅜ x 2½	⅜ x 2½	⅜ x 2½	½
9 to 14	½ x 2½	½ x 2½	½ x 2½	½
16 to 20	½ x 2½	1 x 2½	½ x 2½	1
22 to 30	¾ x 3	1 x 3	½ x 3	1¼

All dimensions in inches. See Fig. 4.

Fig. 8 is a wall bracket, made of wrought iron in one piece, to support small pipes. The hole for the bolt is slotted for ease in adjusting the piping when erecting. For heavy pipes the bracket should be made up of structural

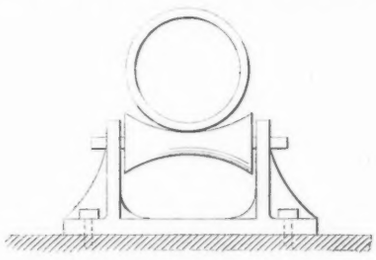


FIG. 9

shapes, such as channel beams or angle irons riveted together.

Fig. 9 is a cast-iron bracket and pipe roller, as ordinarily made to allow for any movement of the pipe due to expansion and contraction.

Petroleum as a Fuel

By M. W. Campbell

Many devices have been invented for the purpose of burning oil with more or less success. There seems to be a drawback somewhere to prevent its more general use as a fuel for steam boilers, but in the writer's opinion there is no fuel equal to it, the most serious objection being its cost per gallon. The writer used fuel oil for which three cents per gallon in barrel lots was paid. This charge brought the cost of fuel rather high, as compared with coal, and the object was to use a fuel that would be cheaper than coal. To burn this oil it was first necessary to design an atomizer that would do the work perfectly, which took a good deal of experimenting. As equipment, there were a locomotive boiler, an upright boiler, a test furnace and a furnace for welding the ends of wrought-iron pipe, and to save the trouble of running to the drug store, a plentiful supply of linseed oil and lime water were kept on hand, as they were needed quite often. It may be of interest to show a few of the different styles of burner that were tried.

The burner shown in Fig. 1 was made of cast iron drilled and tapped to screw on a 1-inch steam pipe, and the top was drilled and tapped for tips made of ⅛-inch iron pipe. The burner would work all right for about 12 hours, when the tips would choke up so much that the burner had to be discarded.

Then came No. 2 burner, which proved a little more efficient, but still had the objectionable point of choking up, and like "Maud," refused to work just at the

critical moment. This burner was soon discarded. Its base was similar to No. 1, the difference being in the tips, which were of bunsen type and, like the other, would carbonize. Burner No. 3 was a good deal like No. 1, only no tips were used. The top part of the base was faced off and drilled full of $\frac{3}{64}$-inch holes. This proved worse than the others and in a

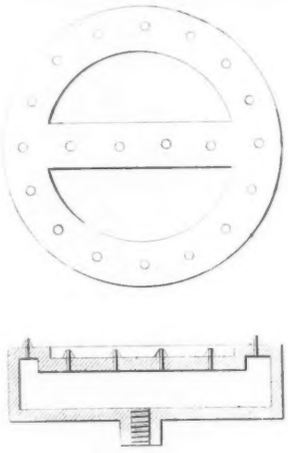


FIG. 1

short time was cast aside. Then came the adjustable burner shown in Fig. 2. This one proved to be unsteady, wasteful of oil and so unsatisfactory that it was thrown away with the others. As shown in the illustration, *A A* are adjusting or flare-ring screws and *B* the flare ring. Becoming somewhat discouraged, work was started on a different style, and in a measure the results were somewhat more successful. This burner, Fig. 3, consisted of a heating coil, a burner and a dash or deflecting plate. The burner proved fairly good, but was more or less dangerous, as numerous explosions occurred from accumulations of oil in pockets of the fittings. These would become filled with oil, which would be forced out suddenly and cause a severe explosion. The

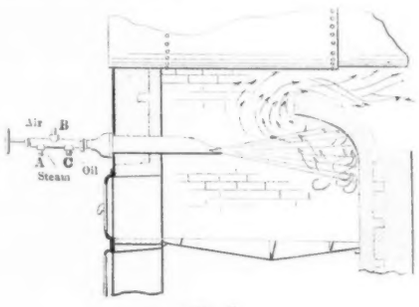


FIG. 5

burner was so constructed that by placing a lot of oily waste or wood around the coil *A*, and lighting this fuel, steam would be generated in the coil and used to run the burner until enough steam was generated in the boiler for this purpose. Then valve *B* was closed and the steam valve was opened to supply steam from the boiler to run the burner. In addition to the explosion of oil in this burner, the coils and straps would burn out frequently, and finding that it would not do, another was made and called the spray burner. This one was not a success for boilers, but proved an excellent burner for glory holes in glass furnaces, and could undoubtedly be used to advantage in welding the ends of pipes for radiators.

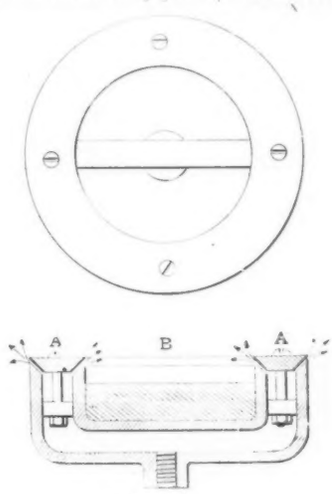


FIG. 2

The burner was started in the same way as the one shown in Fig. 3, and when in full blast, gave out an intense heat.

Finding that the burner shown in Fig. 4 would not answer for boiler purposes, another was made and was known by the name of "frog mouth." This burner gave fairly good service, but also had its bad points, inasmuch as it would occasionally explode the oil instead of burning it steadily. Two of these burners were placed under a boiler that furnished steam for the purpose of hoisting ships up on shipyard ways. All went well until one day when a two-masted schooner was half-way up and one of the burners gave out; the remaining burner was just about able to hold the steam by hard forcing until the boat was up to its place. That settled the burner for this place. The burner is shown in Fig. 5. It was set over the

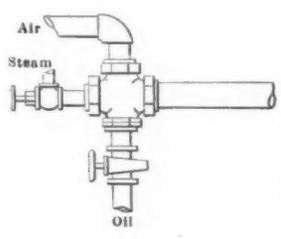


FIG. 6

fire door, and an arch of brick was built out from the bridgewall. The flame from the burner was forced against the arch and passed off over the top and under the boiler. At *B* is shown the air inlet, *A* is the steam inlet and *C* the oil inlet. The burner used more oil than was really necessary for the amount of water evaporated, so the design of still another was started, and after considerable expense and experimenting, a burner was finally obtained which operated easily and economically and produced a steady and high heat. This burner, which is shown in Fig. 6, decided the question of economy of oil over coal. Sixteen of them were put to work in a large factory in New York City and at several other places out-

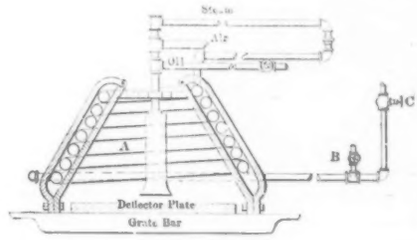


FIG. 3

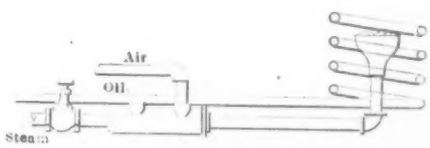


FIG. 4

side of the city. In each place they gave perfect satisfaction. This was in 1887, and as far as the writer knows, they are still in use.

It will be noticed that in all of the burners an air inlet has been provided, as it was found that the best way to burn fuel oil was to admit a proper amount of air into the burner with the oil. Then by properly locating the steam tube, the steam, oil and air were thoroughly mixed together and left the burner in the form of a moist gas, which produced a clear greenish-yellow flame of intense heat, far above that of any coal.

Although the burner shown in Fig. 4 was not much good for boiler work, it had exceptional merit in glass works. The

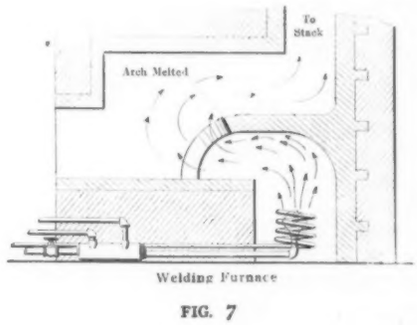


FIG. 7

fire produced by it was of a whitish color and of such intensity it melted the brick lining out of a furnace for welding iron. The arrows in Fig. 7 show the brick arch which was melted down. This was the final test made by the writer, as the board of fire underwriters at that time became a little nervous over the use of oil for this purpose in city buildings.

An Exact Method of Slide Valve Design

Use of the Valve Diagram and a Study of the Exact Relations between Rotary and Reciprocating Motions as Plotted from Actual Values

BY FRANK W. MERRILL

One year ago the writer was employed by a steam automobile company in the capacity of chief draftsman and designer. The company was new, and the machine on which work was being done was the first one built, hence, many new problems were encountered. The design of the engine was made especially difficult by the fact that the superintendent of the company wished to avoid the use of a flywheel and counterweights. In order to accomplish this, and at the same time produce an engine that would run without shock, it was found necessary to figure the valve and link motions very carefully, so as to balance the moving parts and steady the running of the engine by the distribution of the steam on the up and down strokes. Now that the machine is in successful operation, and the correctness of the methods employed has been put to the final test, the writer feels at liberty to make public the various problems presented, together with their method of solution.

The engine was of the vertical cross-compound marine type, rated at about 25 horsepower. In the following discussion the various difficulties that were met with shall be first presented, and then the detail of how they were overcome. Before going into the question of the link motion at all, which is difficult and complex, it will be best first to design a slide valve operated directly by an eccentric, and not consider the problem of reversing the engine or of producing a variable cutoff.

In a design of this kind there are two systems of mechanism to consider. The first is the piston, piston rod, connecting rod and crank—purpose, to change the reciprocating motion of the piston into the rotating motion of the crank shaft; the second is the eccentric, eccentric rod, valve rod and slide valve—purpose, to change the rotating motion of the crank shaft into the reciprocating or back-and-forth motion of the slide valve. The first of these will be spoken of hereafter as the "piston-crank" system, and the second as the "eccentric-valve" system of mechanism.

Angularity of the Connecting Rod

In both of these systems we have a disturbing element which must be taken into account before any accurate work can be done. This is the effect of the angularity of the connecting rod in the piston-crank system, and of the eccentric rod in the eccentric-valve system. This disturbing effect would be nothing if the rods were infinite in length, but practical considerations, especially in automobile work, tend to make these rods quite short, and the influence of their angularity becomes very great.

Referring to Fig. 1, $A\,B$ is the center line along which the back-and-forth motion of the piston and crosshead takes

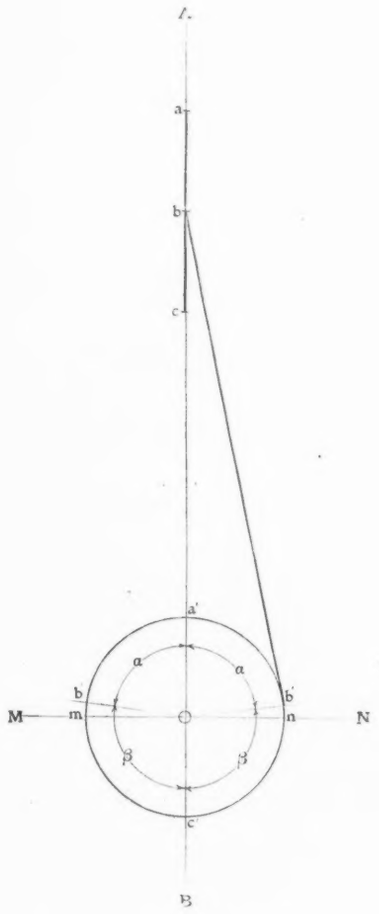


FIG. 1. PISTON-CRANK SYSTEM

place. The circle represents the path of the crank pin, and the distance $a\,c$ on line $A\,B$ the path of the crosshead. When the crosshead end of the connecting rod is at point a on line $A\,B$, the crank-pin end is at point a' on the circle; and, after the stroke has been completed, we have the two ends of the connecting rod at points c and c', respectively. The travel of the crosshead $a\,c$ and the diameter of the crank-pin circle $a'\,c'$ are both equal to the length of the stroke of the engine and to each other. If we take the point b, half-way between points a and c on the path of the crosshead, we have located the mid-point of the stroke, which means that when the crosshead arrives at this point, the piston is just half-way between its upper and lower limits, but the crank pin has not yet reached its central position.

Draw line $M\,N$ at right angles to $A\,B$ through the center O of the crank-pin circle. Points m and n, where this line intersects the circle, are just half-way between the upper and lower dead centers. This is self-evident. Now consider the triangle $b\,o\,n$. It is a right triangle with its base $b\,o$ equal to the length of the connecting rod and with its hypotenuse $b\,n$ greater than the length of the connecting rod. With b as a center and $b\,o$ as a radius, strike an arc cutting the crank-pin circle at the points b'. This is the position of the crank pin when the piston and crosshead have traversed one-half the length of the stroke. The distance $b'\,n$ or $b'\,m$—the amount which the crank pin falls short of the central position between the upper and lower dead centers—is approximately equal to the difference between the hypotenuse and the base of the triangle $b\,o\,n$.

When the connecting rod is long in comparison with the crank, that is, when the base of the triangle is long in comparison with the altitude, this difference is very slight, but as the connecting rod decreases in length, the altitude becomes an important factor in the calculation, and the difference between the hypotenuse and the base of the triangle $b\,o\,n$ increases. For example, in the case of a connecting rod 7¾ inches long, and a length of stroke of 3½ inches, we have a ratio of

$$\frac{7.75}{3.50} = 2.2,$$

and angle α is only equal to 83½ degrees. It is also evident that it makes no difference whether the direction of rotation of the engine is "over" or "under," the same angle α will be traversed in either case during the first half of the actual down stroke of the piston, and the angle β during the second half of the down stroke. Angle β will again be traversed during the first half of the up stroke from c' to

b', and angle α during the second half of the up stroke from b' to a'.

Eccentric-valve System

Let us now consider the problems presented by the slide valve and the eccentric. The eccentric is often regarded as something difficult or mysterious, but such is not the case. It is nothing more nor less than a crank pin, enlarged for convenience to a great size—greater, in fact, than the diameter of the crank circle.

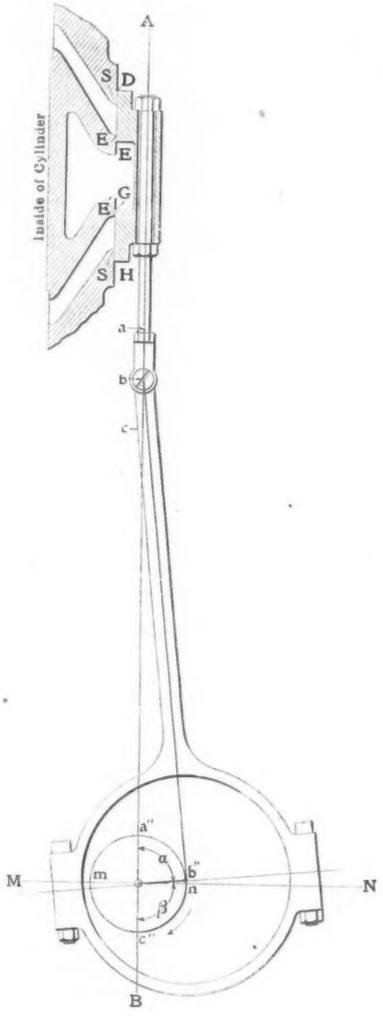


FIG. 2. ECCENTRIC-VALVE SYSTEM

In Fig. 1 is shown the crank-pin circle $a' c'$, whose diameter is equal to the length of the stroke of the engine and whose radius is equal to the length of the crank of the engine from the center of the crank pin to the center of the crank shaft. In Fig. 2 is shown the eccentric circle $a'' c''$, whose diameter is equal to the total travel of the valve and whose radius is equal to the throw of the eccentric, or to the distance $b'' o$ from the center of the eccentric to the center of the crank shaft. The motion imparted to the valve by the eccentric is identical to that which would be given by a crank of length $b'' o$ rotating about the center o. The enlargement of the crank pin to the size of the eccentric does not in any way change the distance $b'' o$ or alter the principle involved. Distance $a c$ on line $A B$ —the center line of motion of the valve— represents the path of the crosshead in the eccentric-valve system, and is equal to the travel of the valve. The figure is drawn with the valve in its central position, and in the section of the steam chest it may be seen that the valve completely covers the ports. In this position, steam is neither being admitted nor exhausted. The distance $D S$ or $H S'$, by which the valve overlaps the steam edge of the port, is called the steam lap of the valve; and the distance $E F$ or $E' G$, by which the valve overlaps the exhaust edge of the port, is called the exhaust lap of the valve.

Now suppose the eccentric crank is rotated in the direction of the arrow. The valve will be drawn down, and as soon as

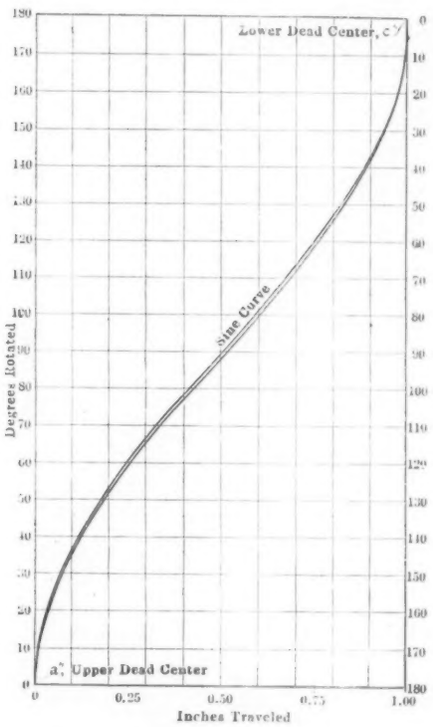


FIG. 3. ECCENTRIC-VALVE SYSTEM

it has traversed a distance equal to $D S$, the upper steam port will be uncovered and admission will begin on the head end of the piston; as soon as it has traversed a distance equal to $E' G$, the lower steam port will be opened to the exhaust and the steam will be liberated from the crank end of the piston. This downward motion of the valve will continue until b'' has reached the lowest point of its travel, c''. Here we have the maximum steam-port opening on the upper end, and the maximum exhaust opening on the lower end of the valve. As the eccentric rotates beyond c'', the valve begins to rise and these port openings decrease; then we have cutoff, or the beginning of expansion, on the upper end, and a closing of the exhaust opening, or the beginning of compression, on the lower end. As the rotation continues, the valve again crosses the central position, and then point H reaches S' and admission begins on the crank end of the piston, and point F reaches E and the upper steam port is opened to the exhaust and steam is liberated from the head end of the piston. The upward motion of the valve continues until b'' has reached the highest point of its travel a''. Here we have the maximum steam-port opening on the lower end, and the maximum exhaust opening on the upper end of the valve. Farther rotation lowers the valve, decreases these port openings until cutoff occurs on the lower end, and the exhaust opening closes on the upper end; then central position is once more reached, and the eccentric has made one complete revolution.

During this revolution, admission, expansion, exhaust and compression have occurred on both sides of the piston, and it is evident that variations in these four events may be produced by giving more or less steam or exhaust lap to the valve, but it yet remains to be shown how much variation can be produced in this way without encountering other difficulties. It has already been demonstrated that the relation between rotary and reciprocating motions in either the piston-crank or eccentric-valve systems depends upon the length of the rod connecting the crank pin to the crosshead. The most convenient way of illustrating this relation for all points of the stroke is by means of a curve, whose ordinates and abscissas represent degrees rotated by the crank pin and inches traveled by the crosshead.

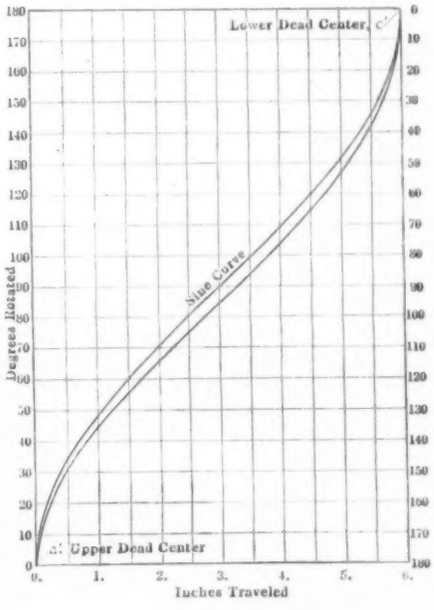
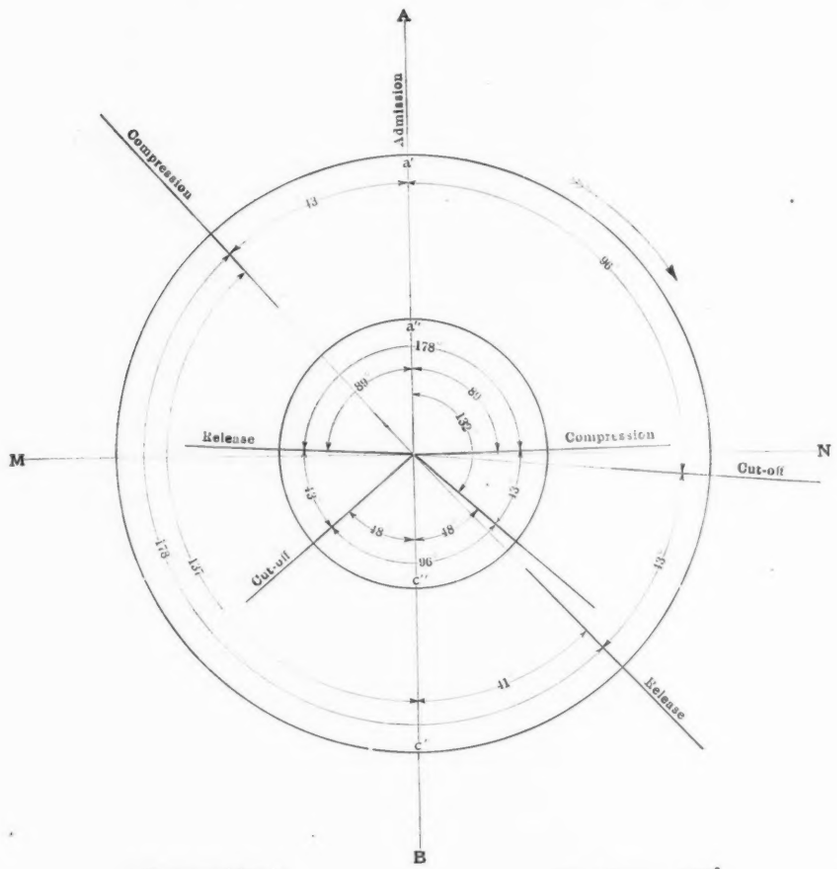


FIG. 4. PISTON-CRANK SYSTEM

If the connecting rod is infinite in length, this relation will be shown by a perfect sine curve, but for practical conditions the curve falls below the sine curve, the amount of the difference varying directly with the shortness of the rod. In all fu-

ture considerations the length of the stroke of the engine will be 6 inches, and the length of the connecting rod 15 inches; the travel of the valve will be 1 inch and the length of the eccentric rod 10 inches.

In Fig. 3 is shown the curve of the eccentric-valve system. Here the rod is 10 times the length of the stroke, and the curve is almost identical with the sine curve. It can be seen that the valve reaches central position, that is, it has traveled ½ inch when the center of the eccentric has rotated 88 degrees. In Fig. 4 is shown the curve of the piston-crank system. Here the rod is only 2½ times the length of the stroke and the curve falls appreciably below the sine curve. It can be seen that the piston reaches central position, that is, it has traveled one-half the length of the stroke, or 3 inches, when the center of the crank pin has rotated 84½ degrees.



Downward Stroke	
Admission	60%
Expansion	30%
Exhaust	10%
Return Stroke	
Exhaust	84.2%
Compression	15.8%

Steam Lap	0.335"
Exhaust Lap	0.005"
Lead	000"
Ang. Advance	42°
Max. Steam Port Opening	0.165"
Valve Travel	1.000"

FIG. 5. HEAD-END DIAGRAM

Developing a Head-end Valve Diagram

Now suppose the problem is given us to design the valve and its mechanism in such a way as to produce cutoff when the piston has completed 60 per cent. of its stroke. In order to solve this problem exactly, a valve diagram will be made use of, which is entirely original, and which is adapted to be used with the curves in Figs. 3 and 4.

Referring to Fig. 5, $A\,B$ is the center line of motion of the crosshead in both piston-crank and eccentric-valve systems, and $M\,N$ is drawn at right angles to $A\,B$. The large circle represents the path of the crank pin and the small circle the path of the center of the eccentric. Point a' is the upper dead center and c' is the lower dead center. The center of both circles is the center of the crank shaft, and the whole figure is a diagrammatic end view of the crank shaft. The arrow shows the direction of rotation, and the circles may be drawn to any convenient scale.

As the stroke of the engine is 6 inches, 60 per cent. of this is 3.6 inches. Referring to the curve in Fig. 4, we find that a piston travel of 3.6 inches corresponds to a rotation of the crank pin of approximately 96 per cent. We will assume that the valve has no lead on the head end, and that the instant the crank pin reaches point a', the steam edge of the valve is in line with the edge of the port, that is, point d coincides with point S in Fig. 2. While the crank shaft rotates 96 per cent., the eccentric must pull the valve down and increase this port opening to a maximum, and then push the valve up again until cutoff occurs. Since the motion of the eccentric is symmetrical with respect to the center line $A\,B$, we simply divide 96 degrees into two equal parts of 48 degrees each and lay these off on the eccentric circle each side of point c''. When admission begins, that is, when the crank pin is on the upper dead center, the eccentric is set 48 degrees above its lowest position c'', which is 132 degrees ahead of the crank. This puts the eccentric 42 degrees ahead of the right-angle line $M\,N$, or in other words, the angle of advance of the eccentric is 42 degrees.

Now let us determine the necessary steam lap $D\,S$ of the valve to produce this result. Referring to Fig. 3, we find that the eccentric reaches central position when it has rotated 88 degrees around from point a''. The distance $D\,S$ must be the amount the valve is pulled down between central position and the beginning of admission. Again referring to Fig. 3, we find that when the eccentric has turned 132 degrees from a'', it has pulled the valve down 0.835 inch. The central position corresponds to 0.50 inch, hence the distance $D\,S$, the steam lap of the valve, $= 0.335$ inch.

The next question that arises is, how much shall we allow the steam to expand before we open the exhaust? This is a matter of opinion and will depend largely upon the work the engine is expected to do; but, in order to illustrate the method and complete the diagram for the head end, let us assume that release occurs at the completion of 90 per cent. of the stroke, or when the piston has moved 5.4 inches, which corresponds to a rotation of the crank pin through an angle of 139 degrees, or 43 degrees beyond the point of cutoff. The exhaust lap of the valve must be of such an amount that the rotation of the eccentric through an angle of 43 degrees beyond the point of cutoff will produce release. This means that release must take place when the eccentric has rotated

$$48 + 43 = 91$$

degrees beyond point c'', which is also 89 degrees from point a''. By looking at the curve in Fig. 3, it is seen that 89 degrees corresponds to 0.505 inch measured from point a''. This means that the exhaust lap of the valve is negative, that is, when the valve is in central position the exhaust port is open 0.005 inch. This result is, of course, theoretical to a certain extent, but depends upon the assumption that release must occur at the completion of 90 per cent. of the stroke. In practical designing it would doubtless be better to make the head-end exhaust lap of the valve,

EF in Fig. 2, equal to zero, which would cause release to occur a very little later. The above result, however, illustrates the accuracy of the method, and it may be easily seen how great an error would have been introduced if we had followed some other valve diagram which failed to take account of the angularity correction of either Fig. 3 or Fig. 4.

The rotating eccentric will now pull the valve up until point a'' is reached, where the exhaust port opening will be a maximum. In traveling from the point of release to point a'', the eccentric has turned through an angle of 89 degrees. Since the motion is symmetrical with respect to the center line, the eccentric will have to rotate through a farther angle of 89 degrees before the exhaust edge of the valve will close the port opening, and induce the beginning of compression in the cylinder. The period of exhaust has lasted throughout

$$89 + 89 = 178$$

degrees of the rotation of the crank shaft. On the crank-pin circle, 41 degrees of this is in the forward stroke, and 137 degrees is in the return stroke. Since there is no lead, compression must be taking place during the remainder of the return stroke, or during the last 43 degrees.

This 43 degrees corresponds to 0.95 inch or to 15.8 per cent. of the return stroke. This looks large, but, in order to be sure that it is too large, it would be necessary to calculate the exact amount of steam remaining in the cylinder when compression begins, and then, knowing the clearance, figure the final pressure reached just before admission. If this is greater than the pressure in the steam chest, then there is too much compression. This may be lessened by decreasing the exhaust lap, which will make release occur earlier and compression begin later. The period of compression cannot be lessened without a corresponding reduction in the period of expansion. One condition depends upon another, wherever a slide valve is used, and it is impossible to change any one of the four phases of admission, expansion, exhaust, or compression without changing one of the others.

Another way to look at it is this: The angle of advance once being fixed, we have the following: Any change in the steam lap will change the end of compression, the beginning of admission, and the beginning of expansion; any change in the exhaust lap will change the end of expansion, the beginning of exhaust, and the beginning of compression. From this it appears that admission is altogether independent of any change in the exhaust lap, and that the period of exhaust is independent of any change in the steam lap; but that a change in either the steam or exhaust lap of the valve will involve a change in both the periods of expansion and compression. Our head-end diagram is now completed and we have: Downward stroke—admission 60 per cent., expansion 30 per cent., exhaust 10 per cent.; return stroke—exhaust 84.2 per cent., and compression 15.8 per cent. The steam lap of the valve is equal to 0.335 inch, and the exhaust lap is equal to —0.005 inch. The angle of advance of the eccentric is 42 degrees, and the maximum steam port opening is 0.165 inch.

Distribution of Steam on Crank End

It now remains for us to work out the diagram for the distribution of steam on the crank end of the piston, so that the impulse of the up stroke of the engine shall be equal to that of the down stroke. This is an important consideration, for we are not permitted to use either flywheel or counterweights, but must obtain all of our balance by an equal distribution of steam. The angle of advance is already fixed, and, when the crank pin is on the lower dead center c', Fig. 6, and is about to begin the upward stroke, the eccentric is 132 degrees in advance of it, or 48 degrees below point a''. If there is no lead, this will allow the crank pin to turn 96 degrees as before during the period of admission. Now let us see what this really means. Referring to Fig. 4, we must now read the curve from the other end. We find that the point on the curve corresponding to 96 degrees rotated from the lower dead center also shows that the piston has traveled 3.03 inches during this time, which is 50.5 per cent. of the stroke instead of 60 per cent. Here we have an illustration of the effect of disregarding the angularity of the rod. We have as yet done nothing to correct for it, and, in consequence, there is a difference of nearly 20 per cent. in the amount of steam admitted. There is only one way to compensate for this, and that is to reduce the steam lap on the lower end of the valve, but the position of the eccentric is fixed, so whatever we remove from the valve will represent so much lead. Lead, however, is just what we need on the lower end to cushion the weight of the unbalanced moving parts. We could resort to high compression to accomplish this result, but the use of lead gives us a chance to kill two birds with one stone.

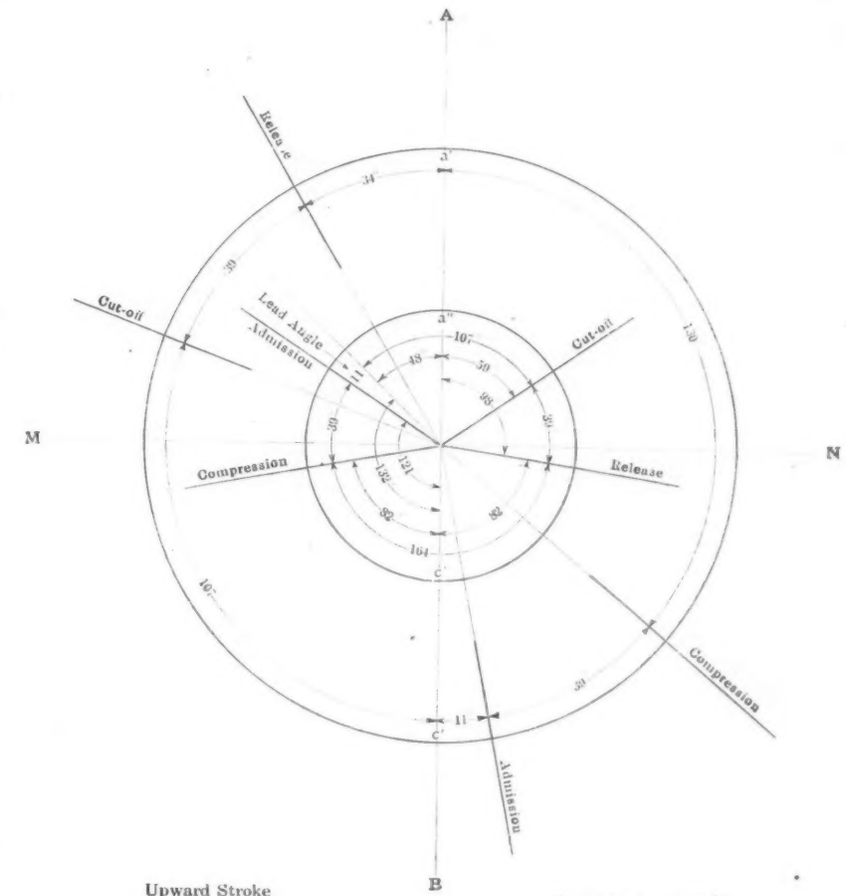


FIG. 6. CRANK-END DIAGRAM

We must, of course, use judgment in regard to the greatest amount of lead we dare give the engine, and this will depend to a certain extent upon the proposed speed of operation. The greater the speed, the more lead we can use and *vice versa*. This matter, however, will have to be taken up afterward and considered in relation to its effect upon the steady running of the engine, and if its importance is great enough to warrant a slight change in the crank-end diagram—with a reduction of the strength of the upward impulse—well and good, the change will have to be made, but the designer will have the satisfaction of knowing that he has taken everything into account, and he will be in a position to study intelligently the results of his design in the first practical test of the engine. From the knowledge thus obtained, he will be able to decide just what is needed to reach the perfection of design possible with the slide valve.

Sixty per cent. of the stroke, or 3.6 inches upward travel of the piston from the lower dead center, corresponds to a rotation of the crank pin through 107 degrees beyond the point c'. When the crank pin is at point c', the eccentric is 48 degrees below a''. In order that cutoff may occur after a rotation of 107 degrees, the steam lap will have to be such that a rotation of the eccentric of

$$107 - 48 = 59$$

degrees beyond point a'' will push the valve down far enough to close the steam-port opening.

By referring to Fig. 3, we find that 59 degrees corresponds to 0.25 inch travel, that is, the valve has moved down 0.25 in order to reach the edge of the port. The amount of the steam lap will be the farther distance that must be traveled by the valve in reaching the central position. This is

$$0.5 - 0.25 = 0.25$$

inch. It will also be observed that the steam port opens while the crank pin still lacks 11 degrees of having reached point c'. The amount of this lead may be read from the curve of Fig. 3, thus: During the 11 degrees, from 121 to 132 degrees, measuring upward from point c'', the valve lifts 0.08 inch, which is the amount of lead, or opening of the steam port, when the crank pin is on dead center. This lead is not very great, and its effect in retarding the motion of the engine is less than would be expected, for, it may be seen by referring to Fig. 4, that the last 11 degrees through which the crank pin turns represents only about 1/20 inch actual travel of the piston. It is only through this small distance that the force of the live steam tends to retard the motion of the engine, and, even then, the crank pin is so near dead center that most of the force of the steam is resolved into a pressure on the crank-shaft bearings.

From this it is evident that the lead is not great enough to be an objectionable factor in the design, and we shall let it remain as it is. On the head-end diagram we allowed 30 per cent. of the working stroke for expansion, and we shall do the same on the lower side of the piston unless we meet with some unforseen difficulty. From Fig. 4 we find that the angle corresponding to a completion of 90 per cent., or 5.4 inches, of the up stroke = 146 degrees. This will be the angular distance from c' to the point of release; but the distance to the point of cutoff is 107 degrees, hence there is an angular difference of 39 degrees between cutoff and release. Cutoff occurs when the eccentric is 59 degrees below point a''. The position of the eccentric at release will, of course, be 39 degrees farther than this, or

$$59 + 39 = 98$$

degrees from point a''. This 98 degrees corresponds to 0.585 inch, which is the distance that the valve has had to drop in order to open the lower steam port to the exhaust. At central position the valve must have still lapped over the edge of the port an amount equal to the excess of 0.585 inch over half the travel of the valve, which is equal to 0.085 inch. In other words, the crank-end exhaust lap is 0.085 inch.

By following the crank-end valve diagram in Fig. 6, we next determine the point of the beginning of compression, which is definite, now that the dimensions of the valve are determined. At point of release the eccentric has turned 98 degrees beyond point a''. During exhaust it must rotate to c'' through 82 degrees, where the exhaust opening will be a maximum, and then up again, through another 82 degrees before the exhaust opening can be closed. We have before determined that the steam port will open when the eccentric is at an angular distance of 121 degrees above point c'', hence there remains

$$121 - 82 = 39$$

degrees for compression.

Working these values out in percentages of the stroke we obtain for the crank-end diagram: Upward stroke—admission 60 per cent., expansion 30 per cent., exhaust 10 per cent.; return stroke—exhaust 85.5 per cent., compression 13.5 per cent., admission 1 per cent. The steam lap of the valve is equal to 0.25 inch, and the exhaust lap is equal to 0.085 inch. By comparing these values with those of the head-end diagram, it will be seen that we have almost identical conditions on either side of the piston. This has been brought about by decreasing the steam lap, and increasing the exhaust lap on the lower end of the valve, to compensate for the variation produced by the angularity of the connecting and eccentric rods. There has been no difficulty in doing this, and with the curves once plotted, it will be found that this diagram can be worked out quite rapidly. The points for the curves in Fig. 3 and Fig. 4 may be found graphically by laying out a diagram similar to Fig. 1, to a large scale, and determining the travel of the crosshead on line $a\,c$ for every 30 degrees rotation of the crank pin from a' to c'.

If it is desired to figure the valve diagram to a still finer point, theoretical cards might be drawn for each end of the cylinder, and then the mean effective pressure on the crank-end card increased just enough to make up for the loss of area occasioned by the piston rod. This is a small matter, however, and goes beyond what would seem to be the practical limitations of accuracy in design.

The object of the article has now been attained. The use of the valve diagram and the curves has been illustrated and these tell the exact relations between the rotary and reciprocating motions in the piston-crank and eccentric-valve systems. The design has been simple, and has offered no particular difficulties, because the limitations of the slide valve have been observed. If an attempt had been made to obtain cutoff at 20 per cent. of the stroke, followed by, say, 50 per cent. expansion, difficulties would have been encountered at once in the way of restricted port openings and enormous compression.

Air Chamber Pumps

By Peter Van Brock

A short filler forming the basis of the following observations appeared in the July 14 issue, page 59. I have had twenty-two years' experience with pumps and have always found that when a long pipe delivers water to a pump, especially when the greater length of the pipe is horizontal, it puts more water into the pump than the recession of the plunger left space for, because water, being practically incompressible, cannot be suddenly arrested, like steam or air. I have always repudiated the term "suction," there being no such condition in any pump.

What takes place when a plunger or piston is drawn back, preliminary to pushing in the opposite direction, is that a partial vacuum is made in the pump, and the external atmosphere, or some other pressure, forces the water in the pipe to move ahead and fill the unoccupied space, then the plunger helps to force the entering water through another pipe into the boiler or tank.

Now, if you have a slide or piston valve on your pump (a very common arrangement), you must have an air chamber; but if you have only the common lift and drop valves, you do not need it, for the energy stored in the water by the outside pressure forces that water past the pump-check valve into the space prepared to receive it.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

Hydraulic Turbine Wear and Corrosion

I have read with interest the article on page 180 of the August 4 issue, on the subject of the "Wear of Water Wheel Blades."

It does not appear that a satisfactory explanation of this corrosion has been evolved. The wear which takes place on these blades, and as is shown in Figs. 10 and 11 on page 181, certainly can hardly be due to the mechanical action of water. Many examples of this erosion have come to the writer's attention, and the following explanation has suggested itself as agreeing with many of the results noted:

Due to imperfect design and varying conditions, there is a tendency to form a vacuum at certain parts of the water wheel. This vacuum brings out of the water the air which has been contained in it. Air which has been bubbled through water, or rather the oxygen in the air which has been passed through water, is not in the ordinary condition but is for a short time a conductor of electricity, indicating that the oxygen is in the nascent state. For a short time, then, this oxygen is an active chemical agent and will attack surfaces with which it comes in contact. The erosion which is formed by sand in the water and which is best seen in the nozzles and buckets of impulse wheels, has quite a different appearance from that which is formed by chemical action. In some installations there have been indications of the corrosion being due to electrolytic action. A definite proof regarding the cause of this corrosion would be of very great interest and should not be difficult.

DAVID B. RUSHMORE.

Schenectady, N. Y.

Shavings Bin Blew Up

The article concerning forced draft, page 881 of the June 2 number, does not describe a new idea, as I witnessed a similar device in 1873 or 1874. A battery of boilers supplying steam for a large wagon factory were being fired with refuse, mostly hardwood shavings, and which were delivered to a large room having a sliding door directly in front of each boiler which, by means of a couple of weights, were easily raised to permit the fireman to pull out as many shavings as required, after which the doors were closed.

To obtain the benefit of the air pressure in the bin, a 10-inch pipe was put into the wall facing the boilers and carried down and opened into the ash-pit, thereby giving a splendid draft and also carrying all the fine dust along and consuming it.

I was machinist for the plant and was so placed that I could look out of a window directly over the boiler room. I was greatly surprised one day to see the roof of the engine room, boiler room and shaving room go up by the window and drop back, with steam, ashes and wreckage of various kinds flying about. Boiler "busted"? No. The shavings bin had blown up; that was all. As soon as possible all hands commenced to hunt for the fireman, who was found buried under the wreckage, but alive and not seriously injured. This is what happened: He fired No. 1 boiler filling the furnace full of shavings and closed the door. A gas explosion blew the door open; the fireman kicked it shut again, and another gas explosion occurred, but in the shaving bin.

Moral: Don't have any connection by piping, or other device, between the furnace and the shaving bin, as fire and the fine dust when mixed with air will not agree any better than two strange cats up a dark alley.

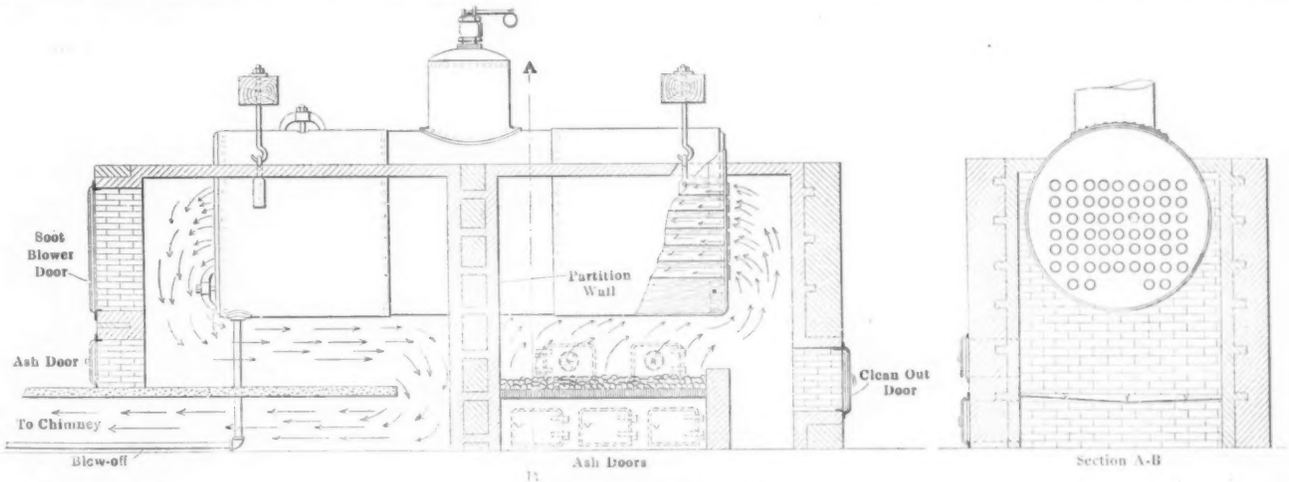
J. H. HERRMANCE.

Hot Springs, Ark.

Improved Boiler Setting

While having some spare time, my thoughts turned to the old horizontal tubular boiler, and I think I have hit upon a good idea. The accompanying sketch will explain itself. In the first place, I believe this form of boiler setting will be more efficient for the following reasons: The circulation ought to be better; the front combustion chamber ought to burn a great deal more of the waste gases, due to the flame striking the firebrick; in other words, acting like a dutch oven. Other features are the short furnace, enabling the fireman to clean fires quickly, and the light fire traps that can be used; also, it is adapted for use in low basements, as the breeching is under the boiler.

I have no doubt that there might be



IMPROVED BOILER SETTING

some improvement, but as I have never seen anything like it, I send it for criticism.

DAN WHEELER.

Mobile, Ala.

A Turbo Generator Experience

The writer recently had an unusual experience with a steam turbo-generator set. It was a 500-kilowatt three-phase 60-cycle outfit, made by the Westinghouse people and erected in a lighting plant in a neighboring city. The writer was superintendent of the plant and looked after the installation of this unit.

The machine was started and had been in service about two weeks, up to which time it was apparently all right and had not yet received more than about one-third load. Without warning, one afternoon, the dynamo end went out of business and refused to generate. The switchboard connections were found to be O. K., so we traced the lines up to the windings of the machine, where it was found that there was a break in the lead to the field winding, which is a wire ribbon laid in a groove in the shaft and then carried in another groove cut into the laminated core of the rotor, as shown in Fig. 1.

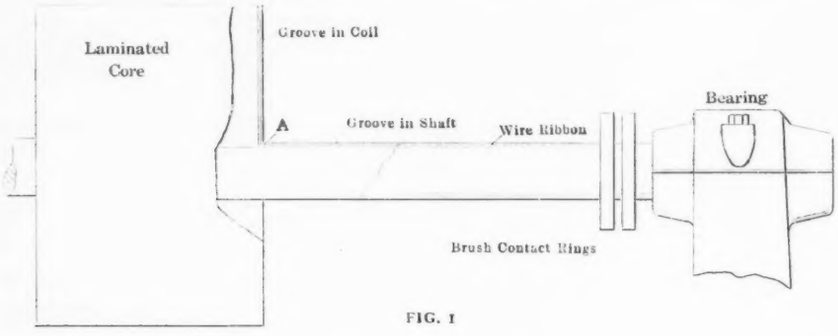


FIG. 1

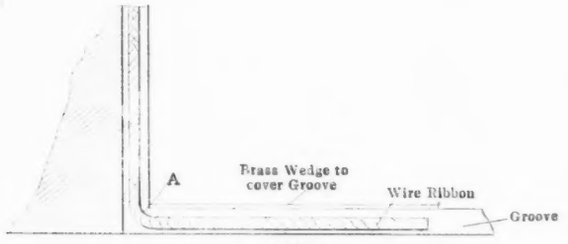


FIG. 2.

TURBO GENERATOR EXPERIENCE

This ribbon (insulated, of course) had been bent at right angles, at the point *A*, to make the turn, but the workman had carelessly made it too short, after the manner shown in Fig. 2. When the cover to the groove was inserted the part which covered the point *A* was driven in with a mallet, and as there was not room enough to drive it flush, as the copper ribbon was in the corner, it cut through it, leaving a few strands of wire connecting. This was the reason the machine generated for two weeks and was all right as long as light loads only were demanded.

W. N. ZURFLUH.

Dayton, O.

Condenser or Heater?

In reply to Markham & Co.'s question, page 153 of the July 28 issue, about installing a heater between their engine and jet condenser, I will give my experience along that line.

About a year ago our firm decided to install a new 500 horsepower cross-compound engine, and I was to install it.

As the combined horsepower of the engines we had at that time was less than 500 horsepower, it was necessary to put in an entire new exhaust line and consequently a new heater.

When it came to the heater my past experience with the layout we were using then taught me that when we ran condensing our feed water was not near the temperature it should have been, as only the exhaust steam from the air pump and boiler-feed pump exhausted into it.

So I began to look around and see if there were any reasons why I could not install the new heater between the engine and condenser. I brought it up before the local N. A. S. E., and all agreed that it could be done.

On account of the heater being below the level of the floor (it being in a basement), it became a problem of how to get rid of the condensed steam in the heater and not destroy the vacuum.

Quite a number of the boys gave their solution of it, but they all required the use of more or less extra apparatus, and that was something I wanted to avoid.

After looking over the different catalogs sent me by the manufacturers of heaters, I found one that I believed would fill the bill.

This heater is horizontal, and has the bottom of exhaust openings in line with the bottom of the heater and by tipping the heater slightly toward the condenser, the water flows into the condenser.

This has proved to be perfectly satisfactory. We have a jet condenser and can get a vacuum of 24 inches and our feed water heated to 210 degrees.

J. L. SHRODE.

Hopkinsville, Ky.

Country Power Station Experiences

While chief engineer of a large street-railway station near Boston, I was desirous of getting into the country on account of my health. Being asked by the promoters of the electric-light company of the town of A to accept the position of chief engineer of their new plant, and being made a good offer, I accepted. I accordingly moved there with my family, and thereby hangs a tale.

By agreement I was to take charge of the station on the first of November, when it would be ready to operate. I reached the town October 1 and began to get acquainted. Just about that time the directors had decided to locate the station some 1100 feet from the dam, giving a 54-foot head of water on the wheel. I found that there was a division of opinion among the directors, and that they had been since July in coming to an agreement where the building should be located. When the superintendent informed me that the plant would be ready to operate by November 1 sure, I told him he had got quite a stunt on his hands.

The station was 40 by 60 feet, 20 feet to the eaves, and was to have a slate roof. They had bought a 15-inch horizontal twin water wheel, with two draft tubes. The last of October the superintendent told me he would need an assistant and that I would go on salary November 1. I began to think there was "a nigger in the woodpile," as I found that the superintendent could not read a blueprint or follow the engine-builder's instructions.

I told him such work was out of my line, but that I would do my best. I was on the job bright and early Monday morning, but no superintendent showed up. I went over the work and got a general idea of what was being done and looked over the plans. I discovered that the mason was carrying the foundation for the wheel higher than the specifications called for. The mason said it was the superintendent's orders. I stopped that part of the work, and the next day the superintendent said the reason for going higher was on account of a ledge in the wheel-pit he had not blasted out, but that it could be done after the foundations

were finished. He also informed me that he would be away most of the time to look after his own affairs, but would come over occasionally and advise me. I found out later that he had been running a saw- and grist-mill before he tackled this last job. A day or two later he came around to see me. I was taking measurements with a steel tape at the time, as I wished to verify the measurements. He informed me that there was a 100-foot linen tape in the desk which was good enough. The foundation proved to be out of square, and 10 inches longer on one side than the other. The superintendent said that it would make no difference, as the foundation was wide enough to "come and go on," and fortunately it was. When the plans for the building came I asked the superintendent if he had brick enough. He said yes. (They had torn down an old chimney.) However, I had to buy 36,000 more. The outside was built of new brick and the inside of old. About that time the directors came to inspect things. They asked me why the specifications were not followed with regard to the wheel foundations. I referred them to the superintendent, who happened to be there. They went to the office and had a consultation, with the result that the superintendent went back to the sawmill, and I took his place.

My first move was to hire a first-class boss mason, as I had to build the dam over, erect piers for the penstock, which was 1100 feet long and 40 inches in diameter. A gang was put on and the dam and piers finished by the second week in December.

The station was built by contract. I also put a gang at work setting poles, 300 being set in three weeks, and the main feed wires strung. The middle of December wound the work up until the following spring, which is another story.

ELMER E. WING.

Pittsfield, Mass.

Oil in Boilers

In the Aug. 4 issue, Sinclair Worth describes how oil got into his boilers by using oil in the step bearing of a Curtis turbine. I have also seen oil pass to the boilers from a leaky bearing and insufficient "seal."

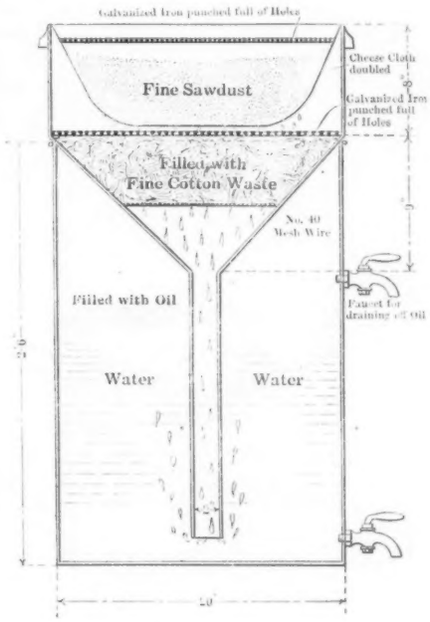
On a 500-kilowatt machine it was the custom of a certain engineer to partially open a valve on a ¼-inch line to the packing rings, and adjust the "seal" by means of the usual three-way cock. More "seal" was required on a light, than on a heavy load, and failure to readjust it when the load lightened, resulted in an impairment of the vacuum, and incidentally all oil leakage around the shaft would be drawn in. I have seen considerable oil pass through to the hot well, and some to the boilers in this manner.

R. O. RICHARDS.

Framingham, Mass.

A Homemade Oil Filter

In a plant where I used to work we made a tank 30 inches high and 20 inches in diameter, with a ring of 3/16-inch wire bound in at the top to give stiffness. We then put in a common plug faucet, with lever handle, about 2 inches from the bottom and another like it 20 inches from the bottom. Next we made an oil receiver and filter chamber, of the shape shown in the sketch herewith, with a 2-inch tube running to within 1½ inches of the bottom of main tank. We soldered in a piece of 40-mesh wire screen and on top of this we placed a layer of picked cotton waste. Above this we fitted a sheet of galvanized iron pierced with small holes not quite 1/16 inch in diameter. We then got two yards of cheesecloth, doubled it, lined the entire remaining space, fastened the edges over the top and filled the chamber to within 3 inches of the top with fine sawdust. On top of all we placed another perforated plate, as shown. By placing the second part into the first, the filter was ready to set to work.



A HOMEMADE OIL FILTER

We put in water, up to within 2 inches of the upper faucet, and then the oil. The sawdust caught all the lint and fine waste matter that collected in the drip pans during the day. The waste in the lower chamber in turn caught any stray particles of sawdust that might accidentally get through the cheesecloth. After passing through the waste, the oil was forced by the pressure from the top down through the tube and, escaping at the bottom, it floated to the top of the water and was freed of all particles of grit during the passage.

Before we made the filter we were using 60 gallons of oil, that cost 50 cents per gallon, every month. After the filter was put in operation we used only 10 gallons of fresh oil every month.

W. E. CHANDLER.

Groton, Mass.

A Case of Bad Valve Setting

In answer to E. A. Stauffer's request, on Page 234, of the Aug. 11 issue, I would suggest that he make an adjustment to the eccentric of the engine from which he took those diagrams, as they show the valve to be working late all around.

Inasmuch as Mr. Stauffer fails to state whether the piston valve mentioned is of the inside- or outside-take type, or whether there is a rocker arm or cross-over in the valve gearing; it is difficult to tell him just which way to move the eccentric, but whatever the type may be, the eccentric must be moved so as to give an earlier admission, which, of course, will give an earlier cut-off, release and compression.

If he will then take more diagrams, he will find an improvement.

A. C. BROWNE.

New York City.

Worn Crank Pins

I noticed an article in the July 14 issue by M. Eastman on "Worn Crank Pins." I think Mr. Eastman has the wrong idea of the real cause of the crank pins wearing on one side. I have never seen or heard of a crank pin being materially worn on more than one side.

An engineer told me that an engine only had power on one end. I was amazed, and asked why he thought so. His reply was: "I have seen quite a number of crank pins badly worn and all of them were invariably worn on one side only."

I explained that on the forward stroke of the piston, the pressure and consequent friction and wear were only on one side of the pin, but that he should not lose sight of the fact that the crank pin turned half over with the first stroke of the engine, and the side that received the thrust of the steam through the rod and brass was on the opposite side to receive the pull of the backward stroke. The pressure gradually diminishes as the rod goes forward and the pin turns over, with a consequent diminishing of the wear on the pin from maximum at the start to nothing, or zero, at the end of the stroke; so that there is practically no wear on the side of the pin next to the center of the crank shaft, for there is never either "push" or "pull" from the rod at this point.

R. S. LIVINGSTON.

Deweyville, Texas.

Diversified Uses of Centrifugal Pumps

In the September 1 number, in my paper on centrifugal pumps, there occurs a sentence on page 377 which I would like to correct. The sentence is as follows:

"It may be noted that for the same lift a multi-stage pump is more efficient than a single-stage pump."

Of course there are many conditions where this statement is obviously wrong, and I would certainly expect exception to be taken to the general terms indicated in this sentence. There are many cases where single-stage pumps are far more efficient than multi-stage pumps and *vice versa*.

The things to consider in connection with the adaptability of one-stage pumps as against two or more stages are the head and the speed. The latter frequently governs, especially with direct-connected pumps where limitations are due to the motor, engine, turbine, or other driver.

Then, again, with carefully considered work, the losses in single- and multi-stage pumps are compared, with high-speed single-stage pumps the safe peripheral velocities and impeller friction as against bushing-ring losses and friction between stages in multi-stage designs.

E. F. Doty.

Camden, N. J.

"How Much Bluff Is Justifiable?"

Under this heading, I have noticed an editorial and several contributions in recent issues of Power and The Engineer.

It is my opinion that "bluff" is not justifiable at all, nor should it be possible for a man to secure a position on a "bluff." It would be a sad commentary on the intelligence of employers as a class, if we assume that they will allow anyone to dupe them into giving employment to incompetents. I find that to secure a position that is worth having, it is necessary to do more than go to the manager and state that you are an engineer, mechanic or something else. To assume that the statement of a probable stranger would be accepted without evidence to support it is an assumption of ignorance on the part of employers or their agents that is hardly warranted.

No employer has the right, morally, to place an inexperienced person in charge of equipment that may, through his inexperience or ignorance, become a menace or positive danger to himself or others, and no man has the right to ask for a position which he knows he has not become competent to fill. It is true that in some unimportant plants we find persons in charge of engine and boiler rooms who are absolutely incompetent and have nothing to recommend them but the low wages that they are willing to accept for their services.

I remember some years ago being called upon to visit a neighboring plant in order to "straighten out" their compound-condensing engine. They were having trouble with the cut-off on the low-pressure cylinder, and could not get the receiver pressure where they desired to carry it. I had advised them to carry about 15 pounds receiver pressure, as, with the load they were pulling, the expansion was well equalized in each cylinder when operating with that pressure in the receiver. When I arrived I found the low-pressure cylinder taking steam full stroke, and the receiver pressure gage standing at 20 pounds. I thought I had the trouble located, but for pastime I applied the indicator, and obtained a diagram on which the admission or steam line was below the atmospheric line, so that with the receiver gage showing 20 pounds, we had five pounds less than nothing, and were carrying a partial vacuum in the receiver. It is hardly necessary to say that the men in the fire room were having no "snap" to hold up the pressure.

The cause of the trouble was this: The cheap engineer who had run on a "bluff" and who at best never promised to be more than a 'bluff," had gone into the engine room to start on Monday morning, and forgot to raise the dash-pot plunger on the low-pressure cylinder or open the proper valve, and as he had the high-pressure valves set with insufficient lap, when he turned steam into the high-pressure cylinder, it blew through into the receiver, and as there was no open outlet from the receiver the pressure was probably raised to that of the boiler or near it. When the relief valve on the receiver popped—it had evidently been sticking—if scattered dirt, grease and other substances all over the room.

There was no stop for the index of the receiver gage to impinge upon, so it was turned as far as the pressure would move it, which was about three times around. This distorted the spring so that the index indicated 20 pounds too high. The impossibility of getting the receiver pressure normal by the gage is apparent. Yet this engineer had lengthened the low-pressure cut-off until the low-pressure cylinder was taking steam to the limit, and the condenser was doing extra duty.

Now is there any excuse for the employee who is so ignorant or inexperienced that he does not understand the A. B. C's of the work of an engineer seeking to place himself in a position where the knowledge and experience of an engineer are absolutely essential to safety, as well as economy? And what can be said in defense of employers who spend good money to install economical equipment, and then butcher the whole proposition by placing it in charge of an incompetent person? The experience here narrated is but one of many that I could give to indicate the folly of an employee seeking to place himself where he does not belong, or an employer risking destruction of property and life by endeavoring to save a few cents a day on an engineer's salary.

I know, however, that there are men who will learn more in a year than others will in five. If the one-year man is of that type, and knows it, and decides to seek a position corresponding to his capabilities, then I say success attend him. I know that there are men of that type but they are a "scarce article." Men who can weigh themselves and give correct weight and a "square deal" to others are not plentiful. But when we find one of them and he forces his way to the front, he is no "bluffer," but a rare type of the "real thing." May his tribe increase.

William Westerfield.

Lincoln, Neb.

I know of several cases where responsible positions have been offered to men who did not expect them. The first happened several years ago. A young machinist heard of an electric road being built on the Pacific coast and wrote for a position as engineer. He had run a simple engine or two, but knew nothing of condensing engines, nor had he ever set a Corliss valve.

He was offered the master mechanic and chief engineer job, and after studying it over for a week, accepted. When he got out there and found compound engines and jet condensers he was up against it, but he didn't lose his nerve. He was only 22, but he took hold and made a go of it and stayed with the company six years or more, when he was offered a position as chief engineer in a new plant in Arizona with a raise in salary, where he is still chief engineer and master mechanic of the company's plant.

It has always seemed to me that if a man has a liking for engineering, has the sand to shoulder the responsibility, and the brains, and is offered a good position and does not accept it, he is a first-class "chump."

M. A. Jaeger.

Matehaula, Mexico.

I would like to say in regard to the matter of "bluff," that the man who puts up an honest one, and has determination behind his bluff, will certainly make good.

There is not an engineer in this country, nor do I believe there ever will be, who has not at some time or other put up a "bluff," for some position just a little better than the one he held. According to my opinion, there is nothing which helps one in the engineering lines so much as self-confidence and grit. Any ambitious engineer who wants to receive a better salary, or hold a higher position than the one he has, must have nerve

and the determination to hold the position, if he gets it. Any man who does this will make good. If every practical engineer who has had an opportunity to get a better position should hesitate in taking it because there was some apparatus about the new plant he was not familiar with, how many practical engineers would be holding responsible positions today?

Any employer who hires an engineer can tell within a very few days after the new man takes charge as to whether he is going to make good or not.

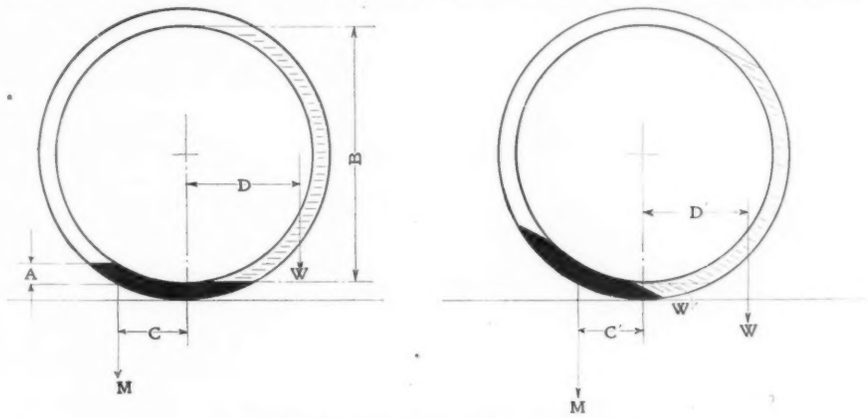
GEORGE A. PURDEE.

Louisville, Ky.

Perpetual Motion

On page 996 of the June 23 issue appears a letter concerning a hollow ring with balanced columns of water and mercury, and asking whether or not the device would set up perpetual motion.

Let Fig. 1 represent the initial condition with a static equilibrium between the mercury on the left and the water on the right. The hight of the water column *B* would be to the hight of the mercury column *A* as 13.6 to 1. But the center of gravity of the water column would be located farther from the perpendicular through the center of support than would the center of the mercury column. This would tend to cause the device to roll to the right.



EXPERIMENT TO OBTAIN PERPETUAL MOTION

Suppose for the moment that during this rolling the mercury and water "freeze," or retain their original positions in the ring. The rolling would continue until the moments of the two columns become equal, and (*M C'* would equal *W D'*), it being noted that the portion of the mercury included with the mercury "column" is constantly increased, and the location of the center of gravity of this column consequently altered. To restore static equilibrium of the two arms, the water would tend to rise in the right-hand arm and the mercury to fall at the left, but it should be noted that there is a certain quantity of water below the lowest confining point on the inner edge of the ring. As a result, some of this water, represented as *W'*, being much lighter than the mercury forming the seal, would filter up through this mercury and come to rest upon the top of it.

What could be expected to take place in the actual experiment would be something like that above outlined, though the water would gradually filter as the ring rolls, until finally the water column on the right is not sufficiently heavier than that above the mercury on the left to overcome the small friction due to rolling the entire device. There would thus be no perpetual motion.

Under the freezing assumption, the ring would roll far beyond the point of equilibrium of moments, and would then roll back again, keeping up this oscillatory motion until the displacement of water to the space above the left arm of the mercury created conditions suitable for equilibrium at rest.

S. G. KOON.

New York City.

Burning Soft Coal Screenings

In response to an article under the above heading in the August 4 number, page 198, I will say that in a power plant in central Illinois in which I worked last winter we had a good deal of experience with soft-coal screenings, but not of the nature stated in Mr. Noble's article.

We had fourteen water-tube boilers ranging from 250 to 300 brake horsepower. The tubes were 14 inches above the back end of the grate. We had about 0.25 to 0.35 inch natural draft over the fire, and we had been burning run-of-mine and running the boilers at about 40 per cent. over rating. One day we received orders to begin burning screenings. Of course, there was a great deal of swearing among the firemen and there were very poor fires for about a week, but we had plenty of boilers to keep up the steam, so it did not hinder the operation of the plant at all. However, the firemen finally succeeded in burning it so as to operate at about 30 per cent. overrating with, as I remember, a saving of from 5 to 6 per cent. in the cost of coal. They carried about a 6-inch fire, and fired often and light, keeping the coal moderately moist and spreading it well.

This spring, when the coal strike came on and we had to burn lump and run-of-mine again, it was amusing to hear the firemen swear equally as hard about having to burn the run-of-mine as they previously had about having to burn the screenings.

As long as we had a fair grade of screenings we had as reliable service as we had with the run-of-mine, but occasionally we would get three or four cars of poor slack, and, if we were not able to mix it pretty thoroughly with the better grade of coal, we would have poor steaming boilers. The main trouble with the poor slack was that it had a great deal of dirt in it, which caused it to clinker badly.

As to warping the grates, we had no trouble that way. If the fires were kept at all hot, they were kept thin enough to prevent the warping of the grate bars.

I have had no experience with the "smoke consumer" referred to, and what is more, I do not care to. I always felt that they not only do not consume smoke, but they prove a positive detriment to the fire. In the first place they cut the draft very severely, for the air is bound to take the easiest path it can find, and it is undoubtedly much easier for it to go through these tubes than through the fire. This, of course, will cut down the intensity of the fire. Then the heat from the coal must heat up this cold air instead of boiling the water, and where the advantage of this is I cannot see, as it will also immediately cool the gases down below the ignition point. One device is to admit cold air about three-fourths of the way up the stack. This will merely check the draft and not cool the gases before they have done their work. The best smoke-consuming provision I know of is to make a large combustion chamber and keep the hot gases away from the cold shell until combustion is complete.

P. M. KING.

Davenport, Ia.

Regarding the question of burning soft-coal screenings or slack coal, it can be burned to some advantage in a hand-fired furnace, and some saving can be made in cost over run-of-mine coal, if it is properly handled.

In the first place the fires must not be allowed to get over 4 or 5 inches thick; the coal should be fired very light and given plenty of time to burn off the gas before another charge is put in. If the coal cakes or runs together very much, it must be broken up about every five or six charges, in order to keep the fire open. This kind of coal takes from 0.5 to 0.8 of an inch of draft at the base of the stack, or from 0.3 to 0.5 in the furnace, to burn successfully.

I once ran a test on a horizontal tubu-

lar boiler with two different kinds of coals, one being lump coal, the other slack coal. The tests showed that it took less lump coal in tons to do the amount of work than it did slack coal, but the slack coal was the cheapest to use, because of the difference in the price. The firemen preferred the slack coal on account of having to break the lumps up. I have used slack coal in my furnaces for the past two years and have had but very little trouble with my grate bars burning or warping out of shape. I get as good economy out of it as I could out of run-of-mine.

GEORGE A. PARDEE.

Louisville, Ky.

Reinforcing the Arches of a Dutch Oven

In reference to H. W. Ginaven's article in a recent number, on arches for dutch-oven furnaces, he might go even farther in strengthening the arch and so avoid crushing at the rear. This can best be accomplished by allowing an expansion space between the top of the firebrick arch and the secondary arch above it. By this arrangement all the weight of the wall above is carried on the secondary arch, which can be made sufficiently strong for this purpose.

Practical experience with arches of this type will demonstrate that expansion is bound to take place, especially at the rear of the arch where the heat is greatest. If a second arch is sprung over the main arch and no space allowed between, when this expansion takes place the effect is to crush the firebrick in the attempt to lift the second arch with the wall above it. Ample expansion space above the arch with another arch carrying the wall above overcomes this difficulty and insures a more durable setting.

G. R. HAIGH.

Detroit, Mich.

Danger of Stopping Above Center

The article by Daniel C. Chittenden, on page 200 of POWER AND THE ENGINEER of August 4 issue, would lead one to think there was great danger of having a hot crank pin if the engine were allowed to stand with the crank above the center, when a centrifugal oiler was used. I do not think the danger as great as represented, so will give my experience, and let others judge for themselves.

We have two cross-compound Corliss engines with cranks set 90 degrees apart which are fitted with centrifugal oilers. One engine has been running more than 15 years, and when stopping, has almost always been set with the low-pressure crank above and the high-pressure crank below the center. During this time I have never known this crank pin to heat because oil did not get to it soon enough. The other engine has been in use for 13 years, and has usually been set in the same position as the other on stopping, and has never given any trouble.

Sometimes these engines have been started under light loads, and often with a heavy load thrown on them immediately, so if there were much chance for trouble from oil not reaching the pin soon enough, I think we would have had some hot pins before this.

If the pin had not been receiving sufficient oil just before shutting down and had become dry, it might heat on starting, but otherwise I do not think it would, unless there was dirt or something to cause heat.

W. O. PERKINS.

Briston, Conn.

In case of a hot crank, I think the practice of stopping above the center is not to blame for the pin being cut and running hot. The engine should be stopped with the crank away from the cylinder in case of a simple engine, because it protects the piston ron from rust and steam in case of standing any length of time; stop it so that there is almost a full stroke to start on, and start up slowly and run slowly for 10 or 15 minutes to give the engine a chance to warm up before getting it up to speed and under load. If an engine runs under and is stopped in this manner it will leave the pin just above center, and therefore will not get oil the first half revolution, but if an engine is started up right the pin will not heat or cut from the causes mentioned in Mr. Chittenden's letter.

I think a man is worthy of considerable censure who would start an engine up so fast that on the first revolution the oil would not have time to get to the pin while below the center.

In a cross-compound engine running over, it would be impossible to stop with both pins below center, and whereas most large cross-compound engines have the stationary crank-pin oilers, I do not see how it is possible for the trouble to be anything else than carelessness on the part of the engineer who started the engine in such a manner.

P. G. JONES.

Lincoln, Neb.

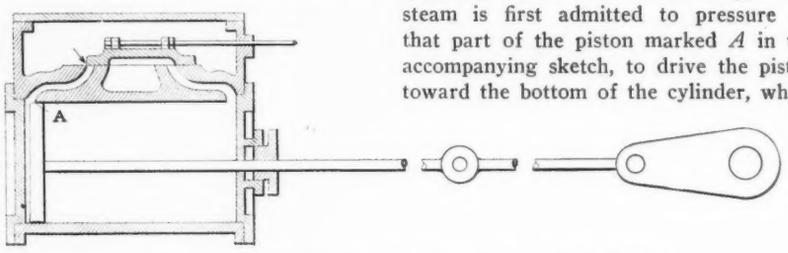
D. C. Chittenden says it is bad practice to stop an engine above the center, owing to the crank pin getting no oil before starting. I think it is good practice to put a little oil on the pin before starting regardless of its position. I also think it is better to stop in different positions, both above and below the center, especially with heavy engines.

L. JOHNSON.

Exeter, N. D.

What Caused the Pound

Replying to William McCann, relative to his inquiry in the July 28 number as to what caused the pound in his Corliss engine when the piston was leaving the head center, there could be several reasons given, but my opinion is that the following will come as near solving the problem as anything that could be said on the matter. My idea is that the piston of the engine over-travels the counterbore and laps the steam ports of the cylinder. If such is the case, the steam piston, being slightly smaller than the bore of the cylinder, would have a tendency, when steam is first admitted to pressure on that part of the piston marked *A* in the accompanying sketch, to drive the piston toward the bottom of the cylinder, which in itself would cause considerable of a pound.



MR. FINCH'S IDEA AS TO WHAT CAUSED THE POUND

Again, in connection with this, if the piston rod should be riding on the lower part of the stuffing box, the weight of the crosshead plus the pull, which in this case I presume to be downward, due to the engine running over, would have a tendency, when the piston is at the head end of the stroke, to hold the piston against the upper side of the cylinder, which would give the steam entering the port, as described, a better opportunity to force the piston down. At first glance it might be reasonable to think that the weight of the piston would counterbalance the weight of the crosshead, which would be true in case the piston was the heavier and there was no downward pull on the crosshead guide. On page 167 of "Power Catechism" is a formula for figuring the pressure on crosshead guides, and by this formula the pressure on this particular engine can be ascertained.

On several occasions I have readily traced a pound in an engine to these defects, although in this particular case this fault may not exist.

GEORGE L. FINCH.

East Cambridge, Mass.

Horsepower of a Steam Engine

On page 993 of the June 23 issue, Mr. Peterson criticizes a statement made by Mr. Darlington on page 692 of the May 5 number in reference to the horsepower of a steam engine, and on page 196 of the August 4 number, Mr. Pearce criticizes Mr. Peterson's article.

Mr. Darlington asked what would be the horsepower of an engine with a 20x20-inch cylinder at 120 revolutions per minute, with an average pressure of 60 pounds per square inch on the piston.

He then answered as follows:

$$\frac{PLAN}{33{,}000} = horsepower.$$

$$\frac{60 \times 2.5 \times 314.16 \times 120}{33{,}000} = 169$$

horsepower.

The correct answer to the above equation is 171 horsepower. But it will be seen that 2.5 has been used for the piston travel per revolution when it should be $2 \times (20 \div 12) = 3.33$, which would make the horsepower 228. This, I believe, is the correct answer.

Mr. Peterson states that this answer is theoretical only and that "developed horsepower equals indicated horsepower multiplied by mechanical efficiency." Mr. Pearce takes exception to this and says that it is not theoretical at all, but is the actual horsepower developed, and that "it is the brake horsepower that is equal to the indicated horsepower multiplied by the mechanical efficiency of the engine."

The statement by Mr. Peterson that the developed horsepower equals the indicated horsepower multiplied by the mechanical efficiency is certainly correct, as is Mr. Pearce's statement that the brake horsepower is equal to the indicated horsepower multiplied by the mechanical efficiency of the engine. The misunderstanding would seem to arise from Mr. Pearce thinking of the work on the piston as the developed horsepower when Mr. Peterson meant developed horsepower as the work delivered at the rim of the flywheel. Common usage terms the work done on the piston as the indicated horsepower, and the work delivered at the rim of the flywheel as the developed, or brake horsepower.

As to the horsepower given by the formula

$$\frac{PLAN}{33{,}000}$$

being theoretical, a short consideration of the definition of the word theoretical would serve to answer the question. In engineering, a theoretical formula is understood to be one that holds only for an ideal case which cannot be reached in actual practice. As this formula gives the exact indicated horsepower of engines in actual practice, it would seem to be far from theoretical and, in fact, rather practical.

In closing, I would state that I agree with Mr. Pearce that the formula given by Mr. Peterson for a "four-cylinder double-acting two-stroke-cycle engine" will give double the horsepower.

JOHN FRENCH.

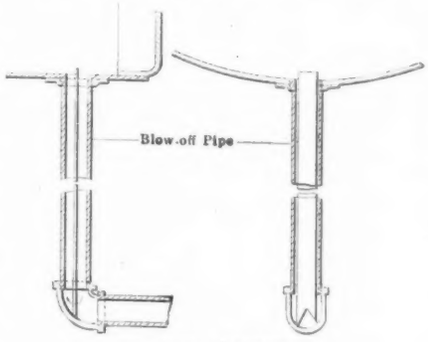
Brooklyn, N. Y.

For Blowoff Protection

In a recent issue was shown an awkward brick contrivance for protecting the blowoff pipe of horizontal return-tubular boilers.

A much better and simpler device is shown in the accompanying sketch, which consists simply of a piece of sheet steel or iron inserted in the vertical part of the blowoff pipe with a swallowtail cut in the bottom where the pipe rests in the elbow to allow of circulation.

This device will insure a circulation in



BLOWOFF PROTECTION

the blowoff pipe, which will not only keep it cool so that it will not burn, but will also keep the whole pipe clean.

WILLIAM O. WEBBER.

Boston, Mass.

Automatic Devices

In the July 21 issue, W. D. Ranney takes a position that I think is unprogressive and indefensible when, in speaking of the use of an emergency valve in the steam line, he says, "An attentive engineer and this valve are far more reliable, in my opinion, than any automatic engine stop upon the market, or an intelligent fireman is more trustworthy than any automatic boiler feed ever invented, for he must necessarily attend to business, and that is just what is required on high-pressure boilers and high-speed engines."

This statement involves several fallacies. No fireman, intelligent or otherwise, is as trustworthy as a correctly designed automatic device properly inspected. The principle of the fallacy of human beings and the absolute certainty of mechanical forces under known conditions is found in all engineering development and in a good part of modern life. We depend upon automatic devices in nearly everything we do, and most improvements to machinery are the result of the recognition of this principle. The first steam engines were equipped with manually-operated valves, but now the valves are automatically operated by the motion of the engine. Does Mr. Ranney think that the boy operating the valves was more reliable than a properly constructed valve gear? The automatic boiler feed, for instance, does many things besides "pulling the chain." It is so designed as to avoid delicate and vulnerable parts and adjustments; it will hold the inflow of water almost exactly equal to the output of steam, thereby utilizing of feedwater heaters and economizers, something that it would be very difficult for a water tender to do, even if he had his hand on the feed valve all the time. The automatic feed-water regulator is not subject to such vagaries as carrying a high level in order to be on the safe side, or of turning the valve the wrong way in a moment of abstraction.

I admit that some automatic and safety devices on the market may be poorly constructed or based on the wrong principle, or not sufficiently tried out in practice, but this is a matter to be investigated by the competent engineer just as he would look into the relative merits of different makes of boilers and turbines.

FRANK MCMAHON.

New York City.

On page 115 of the July 21 number, W. D. Ranney criticizes my criticism of his "simplicity engine stop." I can assure Mr. Ranney that I have seen many engines run away due to the failure of automatic devices, but I have yet to find the case where it was the fault of the automatic device.

If an automatic device, fitted to an engine to prevent it running away, will not stop the engine, its failure will be due either to a design that is not suitable for the purpose, or because it has been allowed to become disarranged. The engineer who allows either of the above causes to prevent the operation of an automatic engine stop would hardly be safe with any kind of a valve. This also applies to automatic boiler feeds, or any other automatic device.

I know there are many things that can happen to an engine besides running away. In some cases the engineer can remedy matters without shutting down, which, of course, is his duty to do if his skill permits him. If he has to shut down, his ordinary throttle valve will do the trick, or he can trip the automatic engine stop, which is easier.

I would suggest that Mr. Ranney test out a properly designed automatic engine stop on his engine and instruct his attending engineer to regularly shut down his engine by means of it, and he will find that in a little while he will have that

feeling of security which allows an engineer to give his whole undivided attention to details as they crop up, instead of having to keep one eye on the throttle, and the other eye on the governor.

FRANK SAWFORD.

Sydney, N. S.

Criticism of Indicator Diagrams

On page 234 of the August 11 issue of POWER AND THE ENGINEER, Mr. Stauffer asks for a criticism of a pair of indicator cards. From the little information given I should say that the trouble is caused by the eccentric being set too near at right angles to the crank. This results in late cutoff, negative steam lead, slight compression, late steam admission and late exhaust opening and closure. In short, the whole round of events is behind time. The cards shown possess all these features to a marked degree, and help to emphasize the fact that no engineer in charge of even one steam engine can afford to be without a steam-engine indicator.

It is safe to say that in this particular case the cost of coal saved by setting the eccentric in its proper position will in a short time equal the cost of the indicator used to take the cards, while all coal saved after the indicator is thus paid for will be clear profit. If more engineers would realize this fact, instead of thinking that as long as the engine turns over the valves are all right, their request for higher pay would be backed by the reduction in fuel consumption which they brought about.

JOHN FRENCH.

Brooklyn, N. Y.

The cards presented by D. H. Yoders for criticism show by the low-pressure diagram that the exhaust is late in opening and the full vacuum is not obtained until nearly half stroke, while the cutoff is too short for economy.

If he will mark the hight of the governor as running (if his load is fairly steady) and then lengthen the cutoff to a point where the governor rises to the highest point, with the load he has, he will probably find he has no receiver pressure.

The object is to get as full a diagram as possible below the atmospheric line so as to make the vacuum effective through the whole stroke. This part should be full the entire length before any pressure appears above the line.

When he has lengthened the cutoff as far as possible and has the governor operative, and there still is some pressure above the line before it shows full below the line, regulate the dashpots so they will be slower in closing so as to get the diagram full below the line.

The above applies to the present load. Should the load increase, he can always tell the receiver pressure to carry by seeing where the governor will be carried the highest and this will be where the terminal pressure is not below the atmospheric pressure, should the load be sufficient to keep the pressure up to the atmosphere the full length.

W. E. CRANE.

Waterbury, Conn.

The Factor of Safety

I feel considerable sympathy for Joseph King, who has given us an account of his appeal examination.

There seems to have been but one detail in which Mr. King was badly in error, namely, his selection of the factor of safety in his boiler calculations.

Doubtless Mr. King, like some of the rest of us, is dependent for his information upon those wiser than himself, and is satisfied to accept the opinions of recognized authorities in engineering matters.

He very likely has read, as I have, that the factor of safety is from 3½ to 5. He may also have read, as I have, that the same factor is used by the United States marine inspectors, but he should have known that the Massachusetts board of boiler rules had decreed that the factor of safety should not be less than 5, and knowing that, there should have been no question in his mind as to the proper factor to be used, for that occasion at least.

In the August 11 issue he is criticized by Mr. Hansen for using a factor of safety of 5 for the boiler without tubes or stays, instead of 8 or more.

For information, against a possible time of need, I would like to ask why a larger factor of safety should be used in one case than in the other?

The factor of safety, as I understand it, is the ratio of the safe working pressure to the bursting pressure; the bursting pressure divided by the factor of safety gives the safe working pressure, and having calculated the bursting pressure for the two boilers, why should not the same factor of safety do for both?

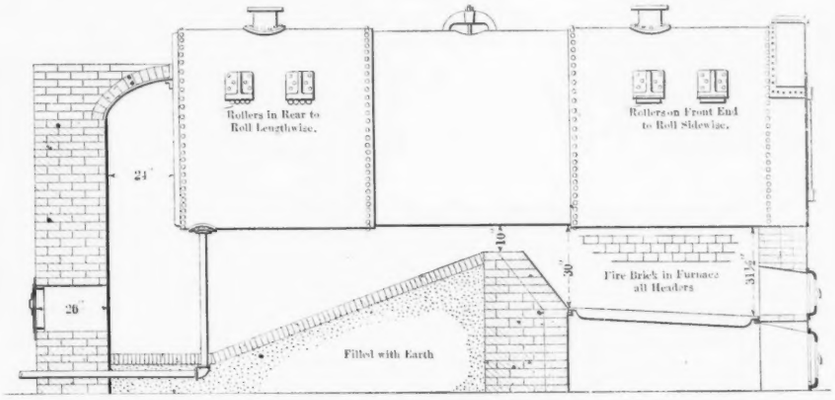
L. W. CLARK.

Providence, R. I.

Poor Boiler Setting

In the northwest corner of Massachusetts, where everything pertaining to the erection and care of steam boilers and engines is supposed to be according to law, a friend telephoned to me to come down and see them erect the brickwork around a 72-inch by 18-foot horizontal-tubular boiler. The company had previously put in three new boilers, paying a local contractor by the day, and it cost $300 per boiler to brick them in, which price the company thought too high. The job of setting the next three boilers was given to their master mechanic, without consulting their chief engineer.

I examined the setting of one boiler, and the first thing I noticed was that the walls were solid, without air spaces in back or sides, and the firebrick in the furnace were all headers laid in fireclay and spaced like an ordinary wall. I asked the boss why he did not put in an air space. He said it was "no good, as it splits the wall in two and causes it to crack."



POOR BOILER SETTING

The boilers carry 150 pounds pressure and are built according to the Massachusetts law for boilers of that strength. They have four steel lugs on each side, two at the front and two at the back, about a foot apart. The rolls were put under the lugs as shown in the accompanying sketch. The smoke flue ran back on top of the boiler and was 24 inches in diameter. The opening in the dry sheet to accommodate the smoke flue was 13x60 inches, but they had built it up until it was 13x26 inches. The flues in the boiler were 3½ inches and there were 94 of them. The boilers were set 2 inches higher than the others in the battery, and the grate was ¾ inch higher than the dead plate and furnace doors, which will give the fireman a jar when he goes to run a slice bar through the fire. The grate is higher in the front than at back, but the company has saved $90 on the brickwork, perhaps.

THOMAS SHEEHAN.

Pittsfield, Mass.

The Gas Power Plant at the Gary Steel Mills

Most of the Alternating Current Units in Position. Some Particulars of the Equipment for Cleansing the Gas for the Engines

BY SILAS R. STONE

The new power plant of the Indiana Steel Company, at Gary, is rapidly nearing completion, as the photograph of the interior reproduced herewith plainly shows. In the foreground, at the right, may be seen one of the two direct-current generators in process of erection, and in line with this are visible eleven of the fifteen alternators. Through the courtesy of the steel company the writer is also enabled to present illustrations of the gas-cleaning plant.

FIG. 1. VIEW IN THE GAS POWER STATION OF THE STEEL MILLS AT GARY

Fig. 4 shows, at the extreme left, the lower part of the dry-dust catcher, which immediately adjoins one of the blast furnaces. Into this the gas passes from the furnace, through four openings, by means of two large pipes known as "downcomers." In this reservoir, which is 30 feet in diameter by 40 feet in hight, a considerable portion of the impurities settles, and the gas passes into another large pipe that empties into a supplementary tank 14 feet in diameter and 25 feet high, one of which serves each pair of furnaces. This tank is shown midway of the illustration and at the side of the stoves, with the dust catcher which belongs to the second furnace lying just beyond it. The structure not only provides an additional dust catcher, but also acts as a valve, being divided into compartments partially filled with water. By increasing the hight of the water in either one, the furnace on that side can be cut out of the system, as desired, and there will be no back-flow of gas from the mains beyond. The two chambers of this tank discharge into a pipe 10 feet in diameter, which carries the gas and remaining impurities into the primary wet washers.

Fig. 2 is a view of the primary wet washers. There are three of these to each pair of furnaces and each has capacity sufficient to take care of the gas from a single furnace; this provides a spare washer for use while one is being cleaned or repaired. These washers are kept about one-third full of water, an overflow maintaining the required level. In them the gas and dust are discharged against the surface of the water from pipes with fluted edges like a petticoat

FIG. 2. THE PRIMARY WET WASHERS OF THE GARY GAS POWER PLANT

and the gas escapes around these edges into openings from a large main. At this point a small percentage of the gas is diverted to special furnaces under a battery of Rust boilers and about 30 per cent. is taken for heating the stoves. The remainder continues on to the secondary washers.

The first of the group of secondary washers are the vertical scrubbers, shown in Fig. 5 between the boiler house and a pumping plant for the cleaning system. These are drums about 14 feet in diameter by 50 feet high, the general exterior construction of which is plainly illus-

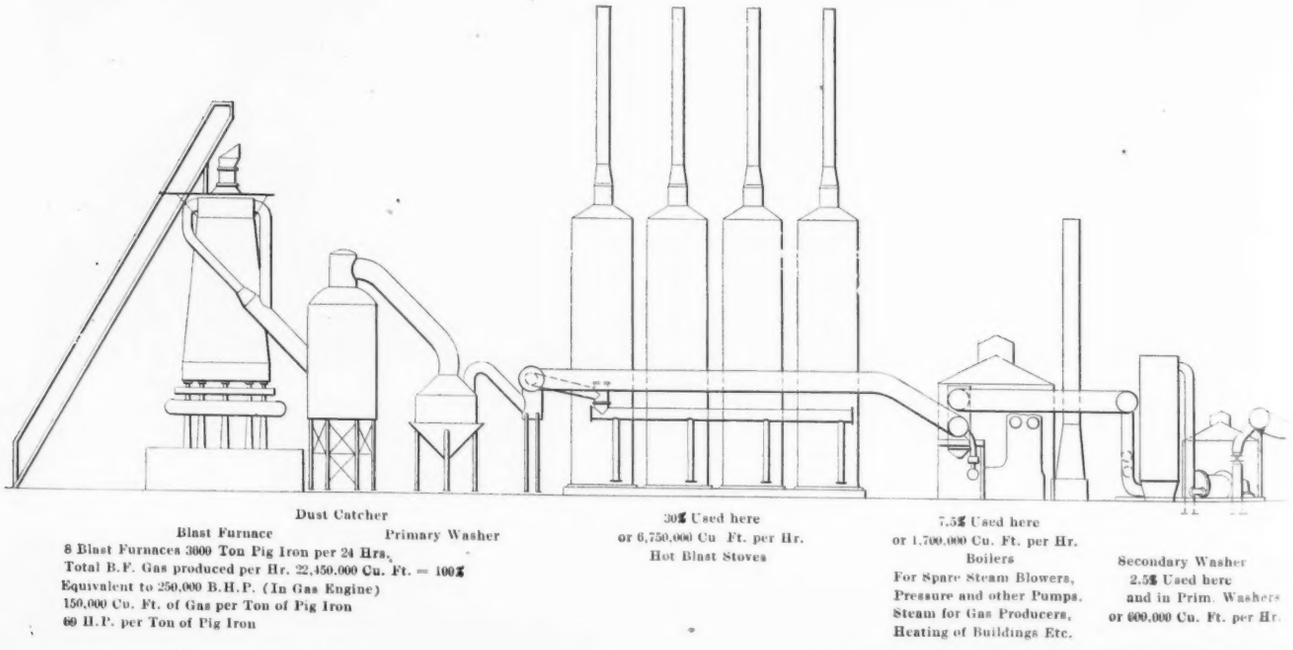

Dust Catcher
Blast Furnace
Primary Washer
8 Blast Furnaces 3600 Ton Pig Iron per 24 Hrs.
Total B.F. Gas produced per Hr. 22,450,000 Cu. Ft. = 100%
Equivalent to 250,000 B.H.P. (In Gas Engine)
150,000 Cu. Ft. of Gas per Ton of Pig Iron
60 H.P. per Ton of Pig Iron
30% Used here
or 6,750,000 Cu Ft. per Hr.
Hot Blast Stoves
7.5% Used here
or 1,700,000 Cu. Ft. per Hr.
Boilers
For Spare Steam Blowers,
Pressure and other Pumps.
Steam for Gas Producers,
Heating of Buildings Etc.
Secondary Washer
2.5% Used here
and in Prim. Washers
or 600,000 Cu. Ft. per Hr.

FIG. 3. DIAGRAM SHOWING THE COURSE OF THE

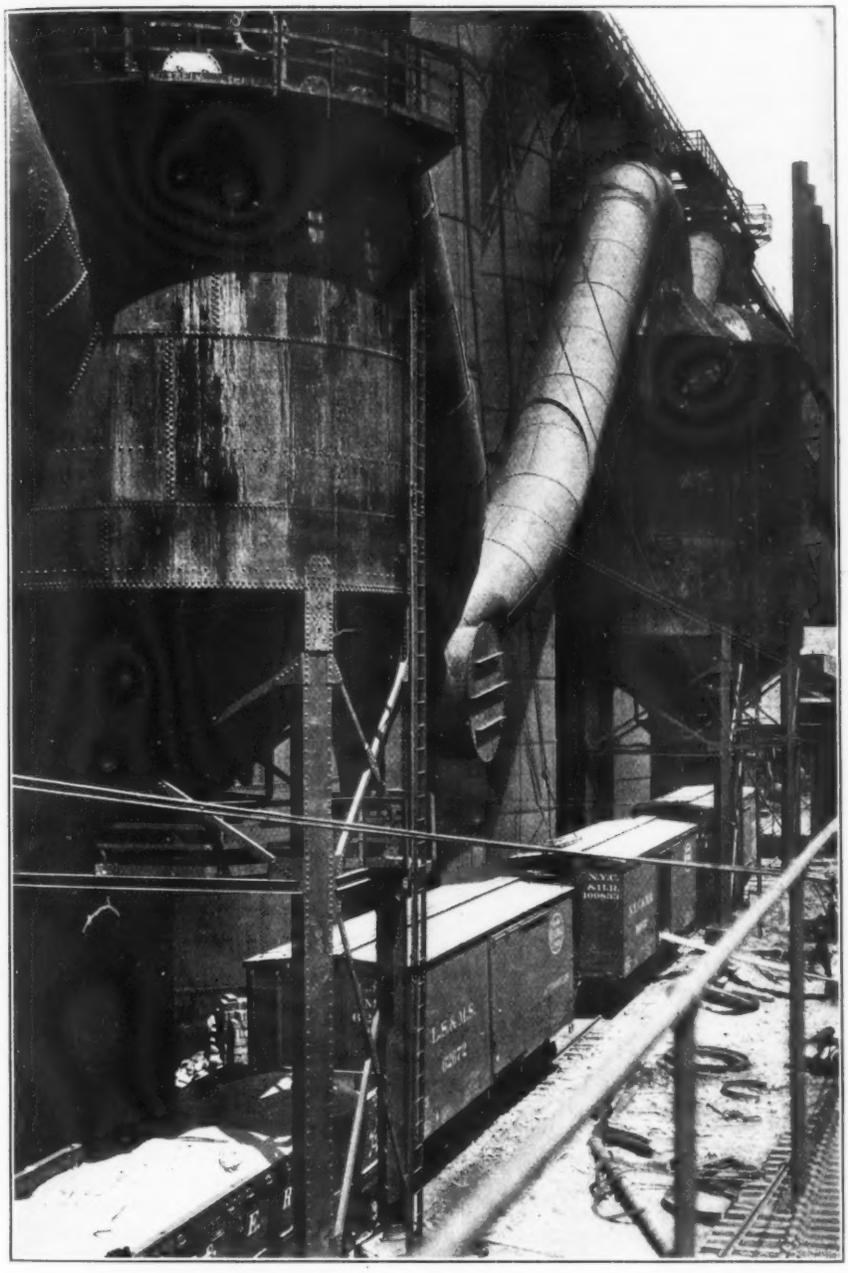


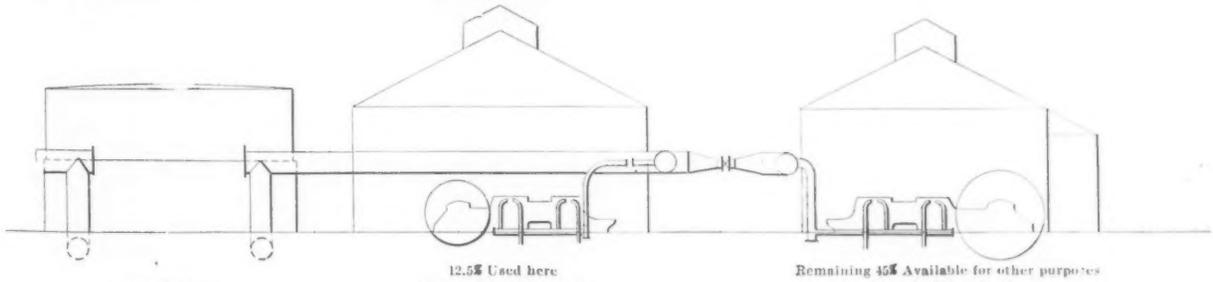
FIG. 4. THE DRY DUST CATCHER IN THE GASPIPE LINE

trated. A torrent of water is delivered in a cascade down through each one, and from near the bottom of the drum comes a stream of gas against it. Rising to the top the gas again passes into the Theisen washers, of which there are four to each pair of blast furnaces. From these final washers, which have been previously described in POWER AND THE ENGINEER, the gas is conveyed under slight pressure to the holders, each of which has 200,000 cubic feet capacity, from which it goes, as required, to the electric power station and blowing-engine houses. The water for the various processes described above is furnished by four large Platt turbine pumps housed in the building shown at the left in Fig. 5.

Fig. 3 is a sketch showing graphically the journey of the gas from the furnace top to the engines, with the quantities available for each of the purposes required. This is computed on the basis of eight furnaces and represents, of course, only a tithe of the enormous volume of gas which will be generated when the steel works reach the full capacity projected. Even with the number of furnaces already under construction and completed, the figures need to be doubled. The present installation of sixteen furnaces will produce about 45,000,000 cubic feet of gas per twenty-four hours, equivalent, when used in gas engines, to 500,000 brake horsepower. The diagram shows how this will be distributed.

To aid in securing maximum economy under heavy fluctuations of load by utilizing the full power of the gas-engine plant without regard to the power required at any given time for the operation of the mills, a storage-battery installation furnished by the Electric Storage Battery Company has been housed in a two-story building 87 feet long by 47 feet wide, located near the power station. The batteries will be kept charged as nearly as possible to their full capacity, in order to assist in meeting, for a considerable period of time if need be, any demands for excessive power made upon the gas-engine-driven generators. These can, in themselves, be heavily overloaded, but the best power factor is, of course, to be secured at about their rated capacity. The battery also aids in maintaining, at light loads, a constant pull on the generating equipment.

The control of the battery charge and discharge with respect to the 250-volt direct-current busbars is effected by means of two motor-driven boosters which may


Gas Holder
12.5% Used here
or 2,800,000 Cu. Ft. per Hr.
Blowing Engine House
2.5% Used for Auxiliaries
for Blast Furnaces themselves
(In Gas Engines) or 600,000 Cu. Ft.
per Hr. Total for Furnace Operation
15% or 3,400,000 Cu. Ft. per Hr.
Remaining 45% Available for other purposes
Electric Power Station
10,000,000 Cu. Ft. per Hr.
Equivalent to 110,000 B.H.P. in Gas
Engines with Gas at 90 B.T.U. per Cu. Ft.
and 10,000 B.T.U. per B.H.P. Hr.
Gas Consumption.

GAS FROM THE BLAST FURNACES TO THE ENGINES AT THE GARY PLANT

be operated singly or in parallel, their field excitation being controlled by an automatic regulator with its actuating solenoid inserted in the total output main of the direct-current generators. The fluctuations of load on the alternating-current circuit are transmitted to the battery by means of a split-pole rotary converter designed to hold constant the alternating voltage while permitting a sufficient range of direct-current voltage to cause the battery to charge from or discharge into the alternating-current circuit through the converter.

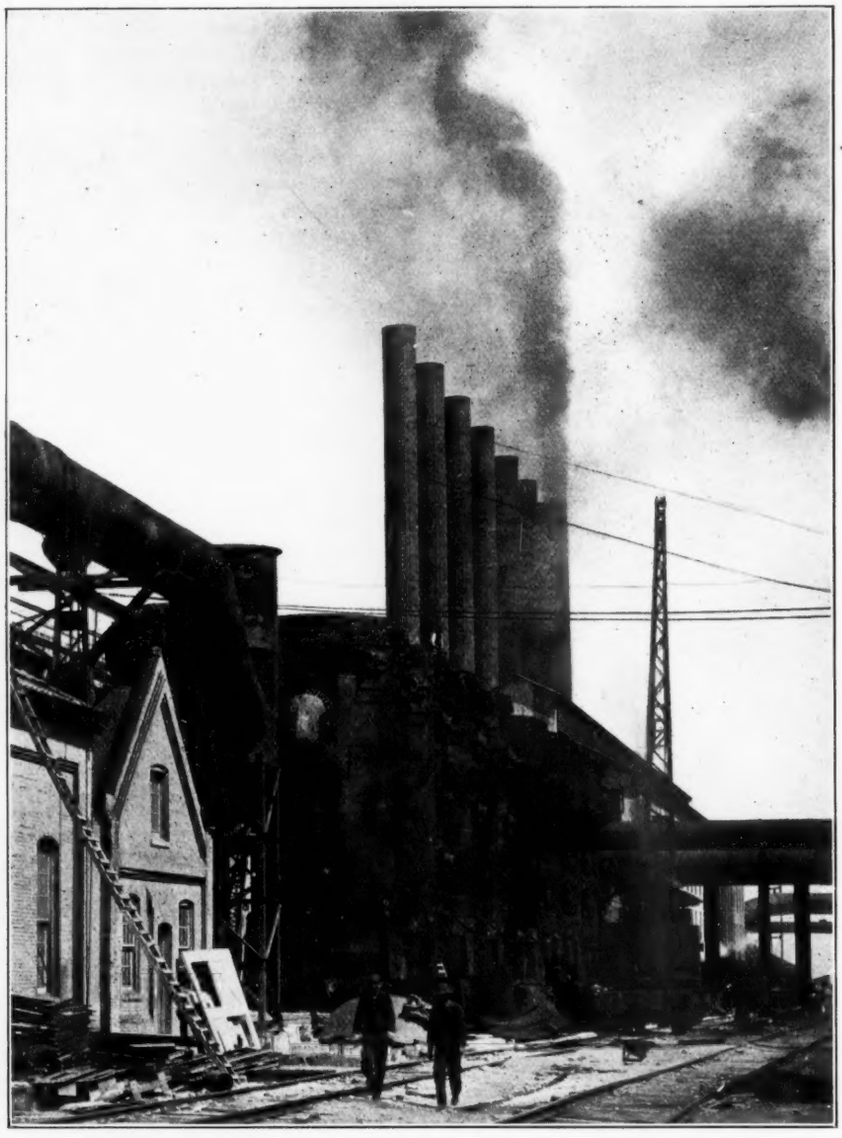


FIG. 5. THE VERTICAL SCRUBBERS AT THE GARY PLANT

The capacity of a deep-well air compressor is one cubic foot for each gallon of water lifted.

Keep all connections and appurtenances in good working order and keep everything about the boiler room clean and neat. In case of accident, keep cool but act promptly and with precision.

Care and Adjustment of General Electric Recording Watt-hour Meters

By O. F. Dubruiel

Commutator Meters

The commutator brushes of a watt-hour meter when shipped from the factory are in an untarnished condition and carefully adjusted. The first care should be to make sure that the adjustment of the brushes was not impaired by the jarring during transportation. The brushes should rest evenly and squarely on the commutator and both fingers should have the same tension. If this tension is too light, sparking is liable to occur, particularly if the meter is installed in a location subject to considerable vibration; if too heavy it introduces excessive friction errors and causes under-registration on light loads; in either extreme condition is liable to roughen up the commutator.

The brush tension may be verified or tested by carefully raising the tip of the brush about ¼ inch from the commutator and suddenly releasing it; if it does not rebound after striking the commutator the tension is about right. Another method is to lift one-half of the brush and note whether the other half leaves the commutator when the first half has been lifted ⅛ inch from the commutator surface. Accuracy at light loads should not be attained by means of brush adjustment, but by following the instructions given below. No lubricant of any kind must be used on the commutator, as this would get between the segments and cause unsatisfactory operation.

Light Load Adjustment

The light-load accuracy of a meter is of great importance to the consumer, and both the commutator and induction type of meters are provided with an adjustable light-load compensator, by means of which the light-load accuracy may be corrected without materially affecting the operation of the meter at any other load.

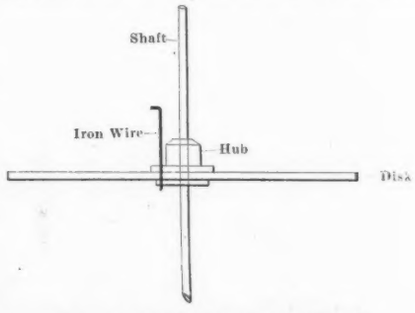


FIG. 1. DEVICE TO STOP CREEPING

After the meter has been in operation for a few months it will show a tendency to run slow on light loads, due to the tarnished condition of the commutator. This should then be corrected, not by cleaning the commutator or brushes, which are now in their normal running condition, but by moving the adjustable shunt nearer to the armature. After this correction, further deterioration at the commutator is not to be anticipated.

A distinction must be made between a tarnished condition, which is constant and does not cause sparking, and roughness of the commutator surface caused by sparking and continuously growing worse. The former condition is natural and should not be altered; the latter should be corrected by smoothing with tape (but not brightening) and the brushes readjusted to give sparkless operation, after which the necessity of further change is improbable.

Creeping of Commutator Meters

Meters which have a tendency to creep (that is, to revolve very slowly—usually imperceptibly—at no load) may be corrected by fastening a small U-shaped

piece of iron wire on the edge of the disk. This will exert a momentary restraining force when it is opposite one of the magnets and is sufficient to prevent creeping on potential above. Such a device is readily constructed by bending a small piece of iron wire (No. 20 B. W. G.) into a close U and slipping it over the edge of the disk.

An adjustment of the effect may be made by sliding the wire toward or away from the center of the disk, thus adjusting its distance from the magnet pole. The iron wire should be as near the edge of the disk as possible without permitting rotation on potential above. After making the adjustment to prevent creeping, the meter should be adjusted for light-load accuracy, by moving the adjustable shunt.

Adjusting the Speed of the Disk

The speed of the disk is controlled by the permanent magnets. Moving the magnets inward, toward the center of the disk, will increase the speed at any given load, and moving them out toward the edge of the disk will decrease the speed at any load.

Induction Meters

The induction meter is provided with a light-load adjustment to correct for variations in local conditions. The device consists of a movable sector located between the poles of an electromagnet. With a meter at rest in such a position that the compensating device is directly between the observer and the spindle of the meter, moving the sector to the right increases the speed at light loads, and moving it to the left decreases the speed at light loads and also tends to prevent creeping. If the sector is moved so far as to put it beyond the field of the electromagnet, its effect will be correspondingly diminished. The adjustment affects only the light-load accuracy of the meter; it has no effect upon the full-load operation, and therefore it is not necessary to recalibrate the meter after making this adjustment.

Creeping of Induction Meters

To counteract the creeping of induction meters an iron wire is fastened to the disk adjacent to the hub, as shown in Fig. 1. This wire should not be moved unless it is positively known that creeping occurs. In that case the wire should be slightly inclined radially away from the shaft. Care must be exercised in doing this, as too great a movement will prevent the meter from starting on light loads. Moving the wire toward the shaft will tend to make the meter run faster on light load. The adjustment when properly made will not interfere with the normal running of the meter, but will prevent creeping on no load. The iron clip must never be used on meters of the induction type, owing to the fact that it would give trouble at the light adjustment.

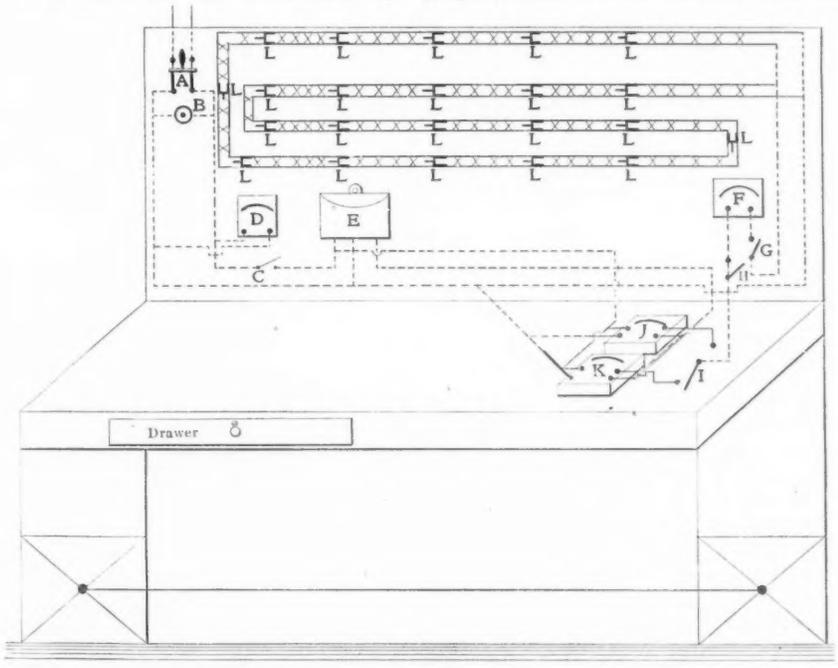


FIG. 2. A CONVENIENT SWITCHBOARD FOR TESTING METERS

Reversing of Commutator and Induction Meters

In case it should be necessary to bring the leads from the line or generator to the right-hand binding posts instead of the left, the meter will run in the reverse direction. This may be corrected by connecting the brush-resistance lead to the opposite connecting clip and reversing the connections of the shunt-field leads. To reverse these connections the lead connected to the binding post should be attached to the remaining brush-connection clip and the lead originally connected to the brush-connecting clip should be attached to the binding post. For induction meters when the line wires are brought to the right-hand binding posts instead of the left, the meter will run slow on light loads. This may be corrected by reversing the leads connected to the light-load adjusting coil.

Loading for Testing

A bank of lamps to be used for a load in testing meters should be arranged and so connected to the switchboard as to permit any desired load to be easily applied; these lamps can be connected in steps of three, four, etc., according to the size of the meter to be tested. Fig. 2 shows a testing board with instruments and a lamp bank, which will be found convenient. A main switch *A* controls the connection with the supply circuit, and a pilot lamp *B* is provided to indicate whether or not the connection and current supply are all right. A single-pole switch *C* serves to open the circuit when removing the meter *E* from the test board; *D* is the voltmeter, *F* the ammeter, *G* a single-pole switch used to connect or disconnect the ammeter, and *H* a similar switch to short-circuit the ammeter leads when the switch *G* is open; *I* is a double-throw single-pole switch used in connecting either of the indicating wattmeters *J* or *K*. The wattmeter *J* has a range of 5 amperes and the meter *K* a range of 25 amperes. Various switches *L*, *L*, etc., are provided for connecting up the desired number of lamps to furnish a load. A drawer is provided in the bench of the testing board. The dotted lines show the wiring of the board, which is on the back, excepting the wiring of the lamps and load switches; this is on the face of the board and indicated by the full lines. This testing board is built up of oak and must stand free from the wall.

Testing Meters

In order to insure accuracy regardless of changes in the room temperature it is necessary that the temperature coëfficient of the disk and that of the potential circuit should be the same. Consequently the temperature coëfficient of the potential circuit is made such that the resistance will be increased by heat generated in the coil. For this reason meters should not be tested until they have been connected in circuit for at least twenty minutes with the potential on; if tested before this they will run fast.

In testing meters a mark should be made on the outer edge of the disk in order that the revolutions of the disk may be accurately counted. The number of revolutions per minute should be so chosen that the time of observation will be from 30 to 60 seconds. If materially less than 30 seconds, errors in the measurement of time are probable and observations of longer than 60 seconds are tedious and generally unnecessary. The operator should be particular to

allow the checking instruments to indicate the loss in the potential circuit of the meter being tested, and *vice versa,* as either would cause an error of appreciable magnitude in the light-load test. The formula for checking a direct-current or a single-phase meter is as follows:

$$\frac{3600 \times Constant \times Revolutions}{Seconds} = Watts.$$

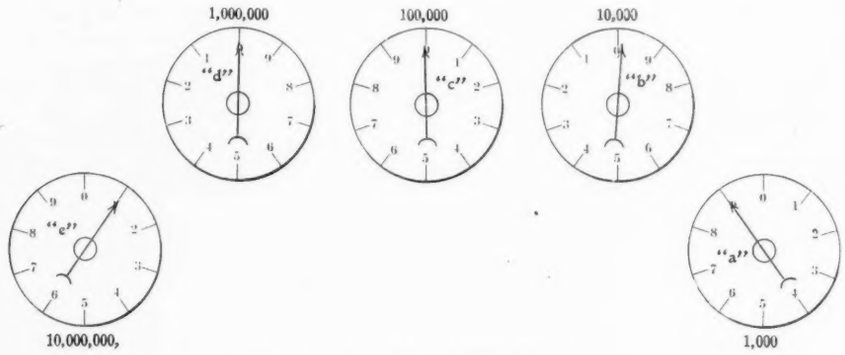


FIG. 3. A SPECIMEN METER READING

3600 = number of seconds in an hour, the "Constant" is the calibrations constant, the "Seconds" are the number of seconds required to make the desired number of revolutions by the disk, and "Revolutions" is that number which is made in the number of seconds through which the test lasts. To test a polyphase meter as a single-phase instrument, use the formula

$$\frac{3600 \times Constant \times Revolutions}{2 \times Seconds} = Watts.$$

The number 2 is necessary in the denominator because the constant as marked on the disk must be divided by 2 in making this test.

Wishing to find the number of revolutions that the disk should make with a given load for a given time, use the formula

$$\frac{Watts\ indicated \times Seconds}{3600 \times Constant} = Revolutions.$$

When the number of revolutions and the load are known, to find the seconds use the formula

$$\frac{3600 \times Revolutions \times Constant}{Watts\ indicated} = Seconds.$$

To find the constant of a meter which is known to be accurate, use the formula

$$\frac{Watts\ indicated \times Seconds}{3600 \times Revolutions} = Constant.$$

Reading the Dials

In determining the indication of a pointer when its position is not immediately clear, the pointer before it (to the right) must be consulted. Unless the pointer before it has reached or passed 0, or, in other words, completed a revolution, the doubtful pointer cannot have completed the division in which it may appear to rest. For this reason ease and rapidity are gained by reading a meter from right to left. For example, in Fig. 2 the first needle, on the dial *a* at the extreme right, indicates 900; the second needle, on the dial *b*, apparently indicates 0, but since the first needle has not completed its revolution (it indicates only 9), the second cannot have completed the division from 9 to 0; hence the second needle indicates 9 also. Similarly, the third needle, on the dial *c*, since the second needle, being between 9 and 0, has not quite completed its revolutions, has not completed its division; therefore it is read as indicating 9. The same is true of the pointer of the fourth dial *d*. The last pointer appears to rest over 1, but since the fourth needle has not actually reached 0, the last one has not completed its division and therefore indicates 0. Putting the figures down from right to left, therefore, the reading is 999,900, though one might erroneously read it 1,009,900.

Boiler Seam Efficiency Table

In the September number of the monthly bulletin of The Fidelity and Casualty Company of New York is published a table of efficiencies of double-riveted lap joints for boilers where steel rivets are used. In the calculations the tensile strength is taken at 55,000 pounds, and the shearing strength of the rivets at 42,000 pounds per square inch of sectional area. It is probable that the Massachusetts allowance of 42,000 pounds for the shearing strength of steel rivets in single shear will become general, though Philadelphia ordinances still allow 45,000 pounds for steel rivets in single shear. The table is used in connection with the following formula for the calculation of the safe working pressure of boiler shells:

$$P = \frac{S \times T \times E}{R \times F},$$

in which

P = Working pressure in pounds per square inch,
S = Tensile strength of plate,
T = Thickness of plate, parts of an inch,
R = Radius of shell, inches,
E = Efficiency of seam,
F = Factor of safety.

TABLE OF EFFICIENCIES IN PER CENT. FOR DOUBLE RIVETED LAP JOINTS.

T. S. OF PLATE—55,000 SQ. IN. AND S. S. OF STEEL RIVETS—42,000 SQ. IN.

Pitch.	Hole.	Thickness of Plate.					Pitch.	Hole.	Thickness of Plate.				
		1-2	7-16	3-8	5-16	1-4			1-2	7-16	3-8	5-16	1-4
2″	1	50.0	50.0	50.0	50.0	50.0	2⅞″	1	65.2	65.2	65.2	65.2	65.2
	15-16	53.1	53.1	53.1	53.1	53.1		15-16	67.4	67.4	67.4	67.4	67.4
	7-8	56.3	56.3	56.3	56.3	56.3		7-8	63.9	69.4	69.4	69.4	69.4
	13-16	59.3	59.3	59.3	59.3	59.3		13-16	55.1	63.0	71.9	71.9	71.9
	3-4	62.5	62.5	62.5	62.5	62.5		3-4	47.0	53.8	63.0	74.0	74.0
	11-16	56.8	65.0	65.8	65.8	65.8		11-16	39.5	45.2	52.9	63.9	76.1
2⅛″	1	53.0	53.0	53.0	53.0	53.0	3″	1	66.6	66.6	66.6	66.6	66.6
	15-16	56.0	56.0	56.0	56.0	56.0		15-16	68.9	68.8	68.9	68.9	68.9
	7-8	59.0	59.0	59.0	59.0	59.0		7-8	61.2	70.2	71.0	71.0	71.0
	13-16	61.8	61.8	61.8	61.8	61.8		13-16	52.8	60.5	70.4	73.0	73.0
	3-4	63.8	64.9	64.9	64.9	64.9		3-4	45.0	51.6	60.0	72.2	75.0
	11-16	53.6	61.1	67.8	67.8	67.8		11-16	37.9	43.3	50.5	60.8	75.8
2¼″	1	55.6	55.6	55.6	55.6	55.6	3⅛″	1	69.1	69.1	69.1	69.1	69.1
	15-16	58.3	58.3	58.3	58.3	58.3		15-16	65.0	71.1	71.1	71.1	71.1
	7-8	61.2	61.2	61.2	61.2	61.2		7-8	56.6	64.7	73.1	73.1	73.1
	11-16	63.9	63.9	63.9	63.9	63.9		13-16	48.8	55.7	65.1	75.0	75.0
	3-4	60.1	66.8	66.8	66.8	66.8		3-4	41.7	47.5	55.6	66.5	77.0
	11-16	50.3	57.8	67.2	69.6	69.6		11-16	35.0	39.9	46.7	55.9	70.0
2⅜″	1	60.0	60.0	60.0	60.0	60.0	3¼″	1	70.3	70.3	70.3	70.3	70.3
	15-16	62.5	62.5	62.5	62.5	62.5		15-16	62.6	71.6	72.2	72.2	72.2
	7-8	65.0	65.0	65.0	65.0	65.0		7-8	54.6	62.3	72.8	74.1	74.1
	13-16	63.5	67.4	67.4	67.4	67.4		13-16	47.0	53.8	62.8	75.2	76.1
	3-4	54.0	61.9	70.0	70.0	70.0		3-4	40.2	45.8	53.5	64.2	77.8
	11-16	45.5	52.0	60.7	72.5	72.5		11-16	33.7	38.5	45.0	53.8	67.2
2⅝″	1	61.9	61.9	61.9	61.9	61.9	3½″	1	68.6	71.5	71.5	71.5	71.5
	15-16	64.3	64.3	64.3	64.4	64.3		15-16	60.2	69.0	73.3	73.3	73.3
	7-8	66.8	66.8	66.8	66.8	66.8		7-8	52.6	60.2	70.1	75.0	75.0
	13-16	60.5	69.1	69.1	69.1	69.1		13-16	45.2	51.8	60.6	72.6	76.9
	3-4	51.5	59.0	68.8	71.5	71.5		3-4	38.5	44.2	51.6	61.9	77.4
	11-16	43.2	49.5	57.8	69.2	73.9		11-16	32.5	37.1	43.2	52.0	65.0

The strengths of the heads and those of seams and other parts of boilers of different types being calculated in other ways, they are not considered.

It is not to be understood that The Fidelity and Casualty Company recommends the use of longitudinal lap seams, but as there are many boilers and pressure tanks in use having this type of joint, the table is of practical convenience.

The Plunger Hydraulic Elevator

Construction, Functions and Operation of the Automatic Stop Valves and Piston Valves; General Arrangement of All Valves

BY WILLIAM BAXTER, JR.

ANOTHER TYPE OF STARTING VALVE

Another design of starting valve is shown by Fig. 252. This arrangement is provided with more simple pilot valves and there are no adjusting valves to regulate the rapidity of acceleration in starting. The plug valves *A B* are for the purpose of adjusting the stopping distance. In starting, water can flow directly into the passage *D* or *D'*, as the case may require, without passing through the holes connecting these passages with *C* and *C'*, which are controlled by the plugs *A* and *B*. This is possible because the valve *V'* is in the central position, but in stopping, this valve is shifted in one direction or the other, just as in the valves of Fig. 250, and the water then has to flow from the passage *C* to *D* through the hole that is throttled by the plug *A*, or from *C'* to *D'* through the hole throttled by *B*. In this design outside piping is not used to connect the pilot valve with the main valve; passages are cored in the castings, as shown clearly in the drawing. By comparing this valve with Fig. 249 and studying the explanations of Figs. 249 to 251, the operation of every part will become perfectly clear. If the lever *G*, Fig. 252, is raised, *K* will be shifted to the left through the action of *K''*, because *F''* holds *K* stationary. If *G* is moved downward, *K* will be shifted to the right. Thus *V'* will be left in the central position when *G* is moved to start the elevator running in either direction. As soon, however, as the main valve starts to move, *V'* will be shifted from the central position because the upper end of F'' moves *K'*.

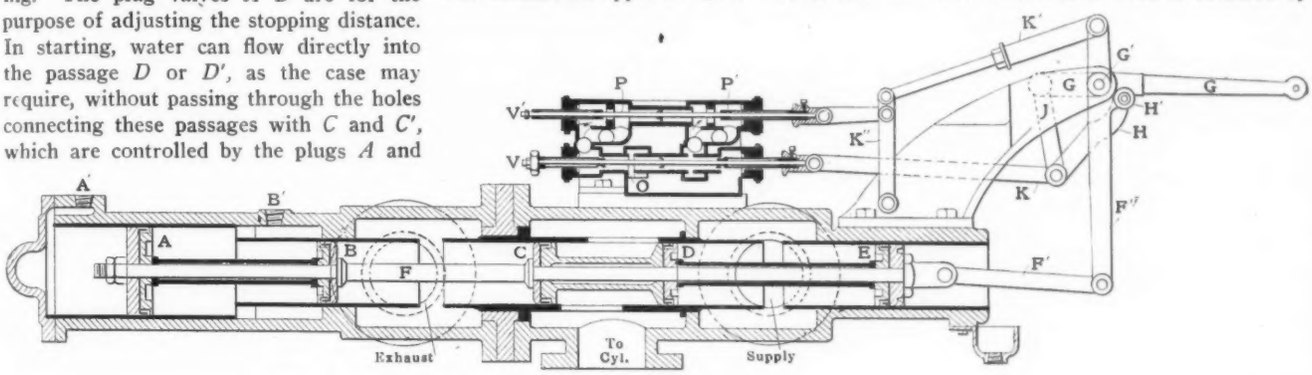


FIG. 249

(Reproduced from previous article)

The main valve of Fig. 249 has five pistons, while that of Fig. 252 has only four. The former valve could also be made with four pistons by simply exchanging the supply and exhaust pipes.

The latest design of operating valves used with the Otis plunger is shown in Fig. 253, and the valve pistons are shown separately in Figs. 254 and 255. An enlarged view of the pilot valve and of the valve *V'* is given in Fig. 256. The principal difference in the main valve is that it is divided into two sections, these being located in separate cylinders, one below the other. On account of this construction, one more piston, *B'*, is required, but on the other hand the pistons *A* and *B* are of much smaller diameter than in Fig. 249. The only function of these pistons is to move the valves and on this account *A* can be made considerably smaller than the valve pistons *C, D, E*, as all that is necessary is that the area of *A* be sufficiently in excess of that of *B* to provide all the force necessary to move the valves, and this difference in area is obtained by reducing the diameter of *B* to the proper point. Although two valve cylinders are provided, they are both of smaller diameter than the single one if Fig. 249, and in addition the length of the valve is considerably reduced.

The pipe *O'* connects the pilot-valve chamber at *O* with the lower valve cylinder at *O''*. The inlet *I'* between the pistons *A* and *B* is permanently connected with the supply pipe so that the full tank pressure is always in this space; hence, when the pilot valve is moved so as to connect *O'* with the discharge, the piston will move to the left, as the pressure on the right-hand side of *A* is greater than that on the left-hand side of *B*, but if *O''* is connected with the supply pipe, through the opposite movement of the

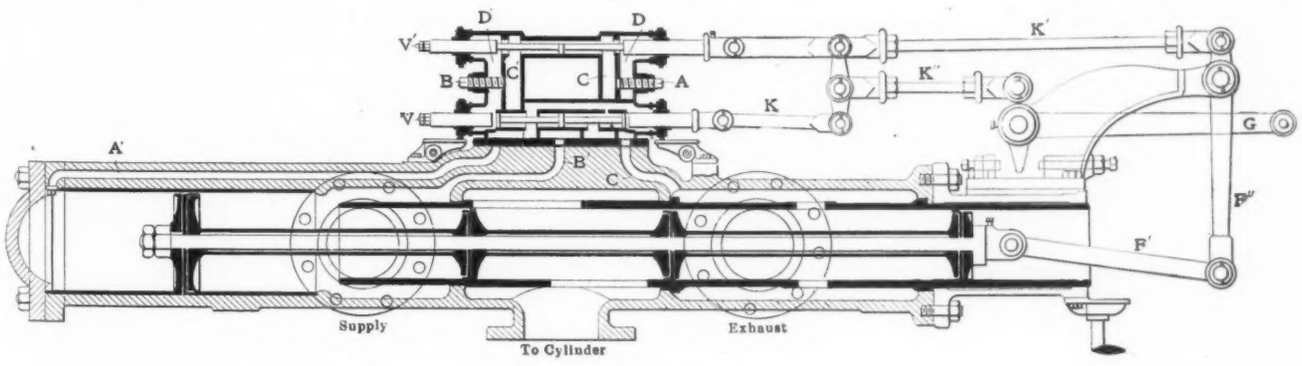


FIG. 252

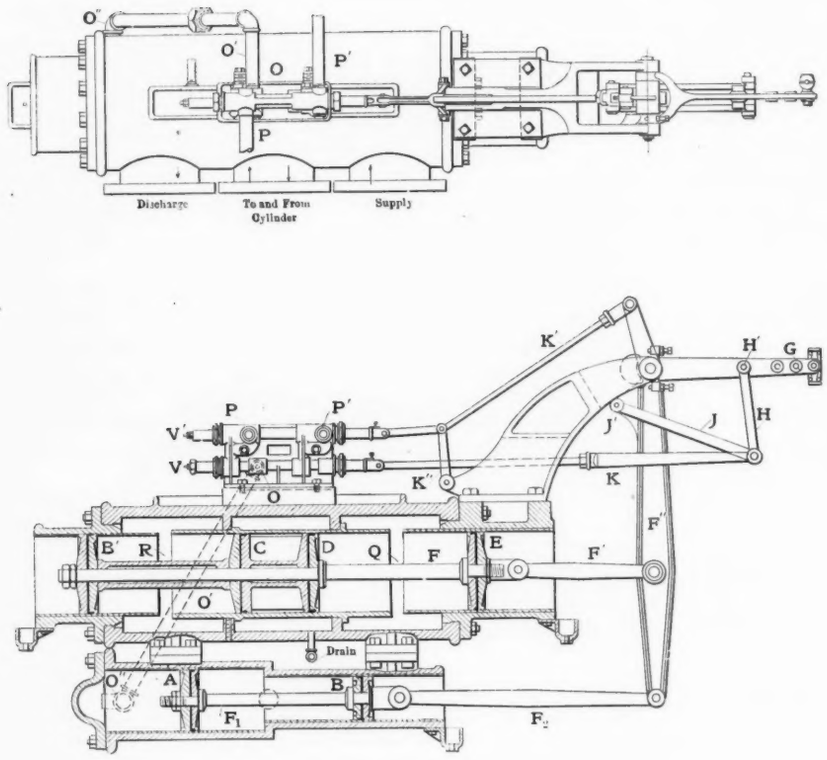


FIG. 253

pilot valve, the pressure on both sides of *A* will be equal, while *B* will be subjected to the full tank pressure on the left-hand side, and only to the atmospheric pressure on the right-hand side; therefore, the valves will move to the right. The construction of the pilot valve and the valve *V'* is clearly shown in Fig. 256. Looking at the sectional view it can be seen that about the only difference between it and Fig. 250 is that the plug valves *R R'* are not used. Experience has shown that they can be omitted as gradual acceleration can be effected in several other ways, as for example, by varying the distance between the valves *L* and *L'* so as to throttle the pasage into *U* or *X* more or less, as may be required, or by varying the diameter of the spacing sleeves between these valves. The external appearance of this valve is shown in Fig. 257. This illustration also serves to make perfectly clear the construction of the levers *F''*, *H*, *J*, *K*, *K'*, etc. The lever *K'* is actuated by an extension of *F''* above the pivot on which this lever swings; hence, in starting, *K'* remains stationary, just as in Figs. 249 and 252.

The main pipe connections are made with the upper cylinder, as this one contains the valve proper, the lower cylinder being simply a motor cylinder. In Fig. 257 only the supply pipe connection *S*, and the lifting cylinder connection *C* are shown, the discharge pipe connection being on the other side. The position of these pipe connections is varied to suit the location of the piping in each particular case, and this location is governed by the shape of the building and the location of the pumps, tanks, etc. The drawing, Fig. 253, shows the three pipe connections all on the same side. In most cases the supply and discharge are more likely to be on one side and the cylinder connection on the other. The two inlets *O* and *O''* are connected with each other, and the inlet *I'* is connected with the supply pipe.

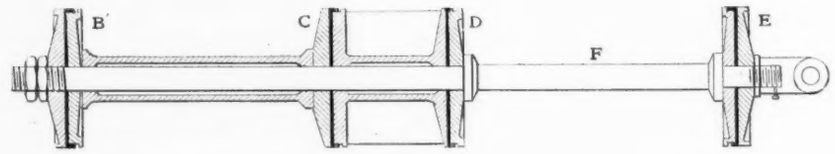


FIG. 254

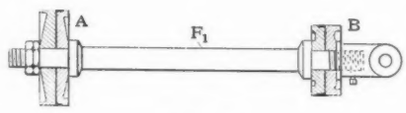


FIG. 255

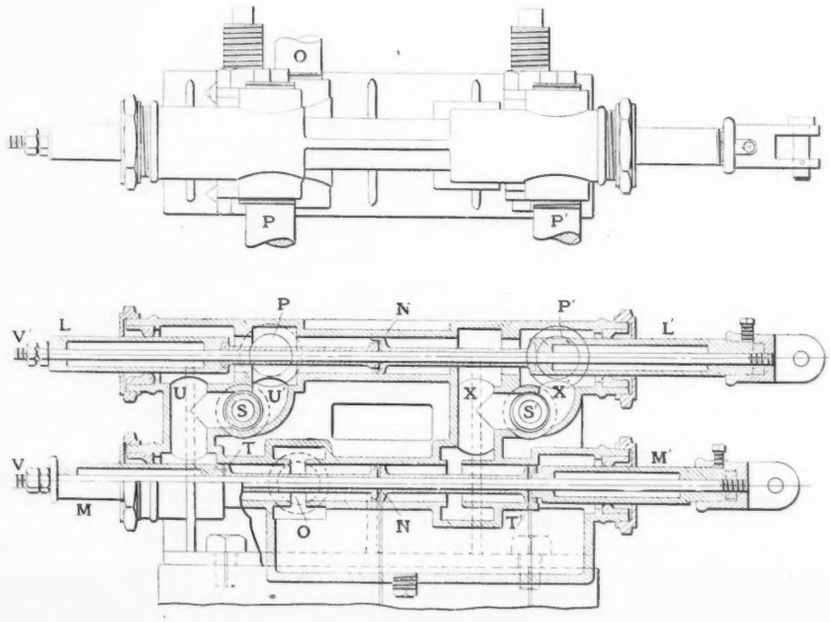


FIG. 256

Automatic Stop Valves

The construction of the automatic stop valves *A* and *B*, of Fig. 245, is very simple. Two of these valves of different design are shown in Figs. 258 and 259. In Fig. 258, the water enters through the inlet *E* and passes out through the opening *F*, whether the valve is connected in the supply or the discharge pipe; in Fig. 245 it will be noticed that in both valves *A* and *B* the water flows in through the top pipe. The piston *A* serves to balance the pressure on top of the piston *B*, and also keeps the water from passing out through the upper end of the valve. The piston *C* acts to prevent the escape of water from the lower end. When the elevator is going up the valve in the supply pipe is in the position in which it is shown in Fig. 258, and the valve in the discharge pipe is raised so that the piston *B* is some distance above the upper edge of the port *P*. When the piston *B* is in

this position, the piston C is just below the port P, so that if any part of the discharge pipe beyond F is higher than P the water in it cannot flow out through the bottom of the valve casing. To catch any drip that may occur, the drain pipe N is provided, and the opening M is for cleaning out this connection if it becomes clogged up. When the valve piston B is above the ports P the water within the lifting cylinder cannot escape; hence, as water flows in through the open supply pipe the plunger is forced upward and the elevator car is raised. When the car reaches the upper floor, the limit valve A, Fig. 245, is closed by lifting the piston B above the ports P, and the car stops. As it is necessary that the car be stopped gradually, the upper edges of the ports P are made to incline toward each other, so

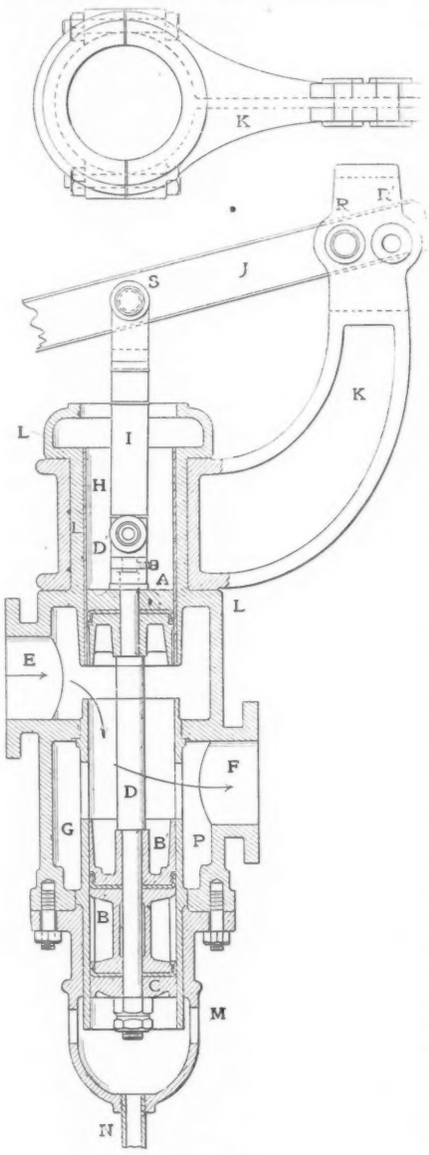


FIG. 258

as to gradually stop the flow of water. When the car is stopped on the down trip at the lower floor by the action of the stop valve B, Fig. 245, the action is the same as described for the up stop, with the exception that instead of stopping off the flow of pressure water into the lifting cylinder, the discharge of water from the cylinder is stopped.

There is a slight difference between the arrangement of the actuating lever J in Fig. 258 and the corresponding lever A'

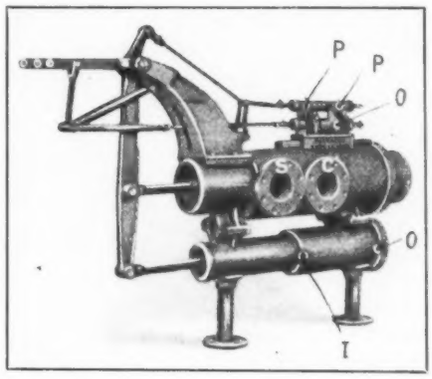


FIG. 257. THE PLUNGER VALVE

in Fig. 245. In the latter the lever is pivoted between the ends and the valve connecting rod is connected with one end. When the valve is so arranged, the piston is depressed to stop the elevator, while in Fig. 258 it is raised. To arrange the valve so as to stop by depressing the piston B, it is necessary that the latter be raised sufficiently to rest above the inlet E when the valve is opened; then if it is depressed below E the flow of water is stopped. To make the valve operate in this way the cylinder lining G is made longer so as to extend up above the inlet E, and the ports P are cut opposite this inlet. The piston B is raised so as to rest just below the bottom of the ports P when the valve is closed and the lever J is in the position shown; then when the valve is opened, by lifting it, the piston B is carried above the ports P and the piston A is raised to the top of the valve cylinder. The valve piston C remains in the same position as in Fig. 258. When this change is made, the cylinder linings G and H are virtually interchanged, although the same linings are not used; H is made long enough to contain the ports P, and G is shortened so as not to project up above the lower edge of the outlet F. The arm K that carries lever J is secured to the valve casing so that it may be moved around into any radial position that may be desired. This construction can be understood from the top view in Fig. 258. The arm K is provided with a clamping cap, and the two parts are bored to fit the upper neck L of the valve casing, so that in whatever position the arm may be set it will come into line with the valve rod D when the cap is tightened up by the clamping bolts.

The valve shown in Fig. 259 differs from that of Fig. 258 in the construction of the piston B and the cylinder lining G. The latter is a short tube without ports, these being formed in the upper portion B' of piston B. When the valve is fully opened, B' drops to the position in which it is here shown, and the ends pass nearly out of the lining G. When the valve is closed the piston B is raised until the cup packing enters the lower end of the lining G far enough to make a joint and stop the flow of water. The ports cut in B' are V-shaped, so that as the valve moves upward, the flow of water is gradually stopped.

The Piston Valves

The construction of piston valves is clearly shown in Fig. 259.

The arm K that supports the actuating lever J, is made with two pivot holes $R\,R'$, in order to adjust the leverage of J for different movements of the actuating ropes. The travel of these ropes can also be adjusted by varying the point of attachment of one and the position of the lever J for the other. The effort required to move the limit valves can also be varied by means of the two pivot holes $R\,R'$, Fig. 259, for if the one nearest the valve

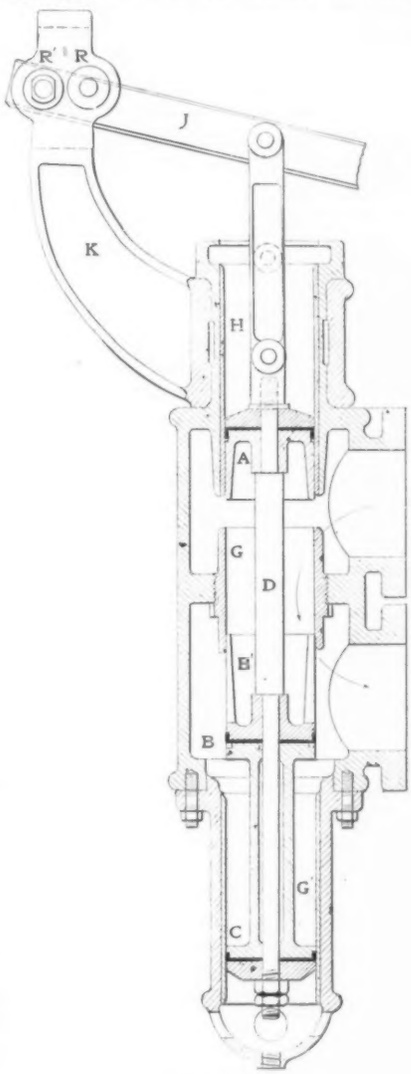


FIG. 259

is used, the lift of the actuating rope will be increased and the pull will be reduced. With small valves, as the frictional resistance is less, the lever J can be pivoted in the hole R, and then less movement of the actuating rope will be required.

POWER AND THE ENGINEER

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Sept. 15	39,000
Sept. 22	39,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	PAGE
The Piping Systems of High Pressure Plants	467
A Troublesome Crank Pin	471
The Three Wire System with Two Dynamos	472
Completion of Gas-engine-driven Electric Generator Installation at the South Works of the Illinois Steel Company	474
Practical Consideration of Gaskets	475
Cleaning Babcock and Wilcox Boilers	478
Hangers and Supports for Piping Systems	479
Petroleum as a Fuel	480
An Exact Method of Slide Valve Design	482
Practical Letters from Practical Men: Hydraulic Turbine Wear and Corrosion....Shavings Bin Blew Up....Improved Boiler Setting....A Turbo Generator Experience....Condenser or Heater?....Country Power Station Experiences....Oil in Boilers....A Homemade Oil Filter....A Case of Bad Valve Setting....Worn Crank Pins....Diversified Uses of Centrifugal Pumps....."How Much Bluff is Justifiable?".....Perpetual Motion....Burning Soft Coal Screenings....Reinforcing the Arches of a Dutch Oven....Danger of Stopping Above Center....What Caused the Pound....Horsepower of a Steam Engine....For Blow-off Protection....Automatic Device—Criticism of Indicator Diagrams....The Factor of Safety....Poor Boiler Setting	487–494
The Gas Power Plant at the Gary Steel Mills	495
Care and Adjustment of General Electric Recording Watt-hour Meters	498
Boiler Seam Efficiency Table	500
The Plunger Hydraulic Elevator	501
Editorials	504–505

Preparing Peat for Fuel

After half a century of experiment with peat in attempting to produce a commercial fuel which would give satisfaction in the power plant and for domestic uses, it would appear that the problem has finally been solved by Dr. Martin Ekenberg and a process devised which has the earmarks of success. Heretofore, the difficulty in making peat as good and as cheap a fuel as coal has been in getting rid of the excessive moisture always contained in the raw material. For this purpose mechanical means were of no avail, and, although the peat could be dried artificially, the expense of drying a substance containing normally about eighty-seven and one-half per cent. of water was prohibitive. Even drying the peat by exposing it to the air failed to produce a fuel as cheap as coal, and did produce a combustible which, weight for weight, had from four to five times the bulk.

The success of Dr. Ekenberg's process lies in the discovery that peat, exposed to a temperature of over 150 degrees Centigrade in a closed vessel, will char and lose its property of retaining water, the greater part of which could then be pressed out at small expense. In logical order, the method consists of first taking the wet peat from the bog, passing it through a specially constructed cutting machine which reduces it to a homogenous mass, and by means of special pumps forcing it in a continuous stream through the carbonizing ovens, where it is subjected to a moderate temperature and a pressure of 200 to 320 pounds per square inch. It is then passed through a mechanical press, and all but eight to fourteen per cent. of the water removed. This small amount is evaporated by a final drying by means of waste heat from the carbonizing ovens, and the peat is then ready to be made into briquet form.

By this process it is claimed that all of the valuable volatile constituents such as tar and the gaseous hydrocarbons are retained, and as the briquetted peat contains from 10,200 to 12,500 B.t.u. per pound, its value as a fuel is practically equal to that of ordinary coal. In burning, the briquets give a long, clear flame, and as they contain but the slightest trace of sulphur, no injury results to ironwork. When submitted to dry distillation, the briquets give off a coal gas of good quality and are reduced to a hard coke suitable for metallurgical purposes. In addition to these advantages, it was found in a recent locomotive trial that the new fuel was smokeless and that cinders were not produced.

The total cost of production, including the price of the raw peat; wages for excavation, transport and in the factory; depreciation and maintenance of plant, and administration expenses, is said to be in the neighborhood of $2.20 per ton, and this cost, it is believed, can be appreciably reduced by adopting modern excavating machinery. An experimental plant has been in operation for some time at Stafsjö, Sweden, and the results there obtained should prove of exceptional interest.

The Dreadful Fate of the Steam Engine

Relegation to the scrap pile has been so often prophesied as the early fate of the steam engine that little or no attention is paid to these dire predictions by any save the prophets, their immediate disciles, and a few readers of the popular-science notes in the daily newspapers. The gas engine, with its promise of a horsepower-hour per pound of coal, and the steam turbine, with its kilowatt-hour on 13 pounds of steam, have both been cited as the diggers of a grave broad and deep for the tireless servant of a century and a half of civilization; but for some perverse reason the piston steam engine refuses to follow the sickle and the spinning-wheel into oblivion. Some years ago there was installed in a mill in Belfast, Ireland, a steam engine of some 400 horsepower which discharged only 8½ pounds of water per horsepower-hour at the outlet of the surface condenser at normal load. Recently there has been installed at the Central Lighting Station of Brussels, Belgium, a steam engine of 4000 horsepower, which between half load and full load consumed an average of 9½ pounds of steam per hour per indicated horsepower. An English engine-building corporation advertises its ability to install engines with cylinders of 19 and 41 inches in diameter, which shall, under certain specified conditions, develop 600 indicated horsepower with a water consumption of not more than 9¼ pounds per indicated horsepower-hour. It is at least regrettable that these superior results are always obtained so far away that verification is difficult; but allowing full credit to the reports leads to the conviction that the steam engine is in no immediate danger of becoming extinct.

From news items, such as the foregoing, that appear from time to time in the technical press, it is almost, if not quite, certain that in the race for first place as a power producer of combined reliability and economy the steam engine will not be seriously excelled by either the gas engine or the steam turbine. It is not impossible that the high degree of economy reached by an occasional steam-engine installation may in the near future become ordinary practice, and that a steam consumption of 9 pounds or under per indicated horsepower-hour, instead of being telegraphed around the world as something phenomenal, may become as common as the 16-pound steam consumption of everyday compound engines.

However this may be, it will doubtless remain true indefinitely that the piston steam engine, the steam turbine and the gas engine all have their legitimate respective fields in which they are each practically invincible.

Electric Traction and Coal Consumption

In a communication to one of the daily papers a correspondent calls attention to what he considers the facts that the consumption of soft coal is decreasing because of the increased use of electric power by the railroads, and that the soft-coal trade is injured thereby. If all of the railroads of the country should change from locomotive to electric traction there is no certainty that this change would result in any perceptible reduction in the quantity of coal used in transportation service. It has never been claimed that the electrical transmission of power was more economical than the mechanical; it has always been adopted on the score of convenience rather than for economical reasons.

The proportion of coal used by railroads has steadily decreased from something over 40 per cent. of the total quantity mined in 1886 to less than 35 per cent. of the total output in 1905, which is the latest date for which any reliable statistics are available. During the same period the percentage used for domestic and industrial purposes increased from 28 to 42 per cent. of the total coal mined. While the percentage of coal used by the railroads is decreasing, the actual quantity used by them per annum is increasing enormously; 97,000,000 tons of coal was thus burned in 1905—an increase over the previous year which if continued at the same rate year by year for the next seventeen years will carry the coal consumption by railroads over 240,000,000 tons for the year 1925. It is evident, therefore, that although the railroads are using a smaller proportion of the total coal mined they are still using a regularly increasing quantity, and the steady rise in price indicates that the soft-coal trade is not being injured to any appreciable extent by the electrification of a few suburban railroad lines.

While it is not probable that the coal deposits of this country will approach exhaustion before better methods of obtaining heat, light and power are discovered and utilized, it is interesting to note the effect of the enormous demand upon the different coalfields. Coal which is being sold today from many mines was only a few years ago unmarketable, because of the existence of better seams which have since been exhausted. That this feature in the history of the coal situation will be many times repeated is highly probable, and calculations, based on the extent of known coalfields and the estimated increase in the consumption, purporting to show that all of our coal will be gone in two thousand years savor much of unthinking guess-work.

Speed of Flame Propagation in Gas Engine Fuel Mixtures

Dr. A. Nägel, of the Dresden High School, recently conducted some interesting experiments to determine the rates at which flame propagation is produced in mixtures of gas and air such as are commonly used in gas engines. The experiments were made with the spherical bomb employed some years ago in Prof. Langen's investigation of the explosive pressures of hydrogen and carbon monoxide, the mixture being ignited in the exact center of the bomb, which was about 15¾ inches in diameter.

With both illuminating gas and producer gas Dr. Nägel found that for high percentages of gas in the mixtures the initial pressure, which ranged up to 114 pounds per square inch, influenced the speed of the inflammation only slightly. In mixtures of low gas proportions the initial pressure had a distinct influence; the greater the pressure, the slower the flame traveled. With an 8 per cent. coal gas and air mixture the flame went out after being started, and the combustion was not complete even after ten explosions. The speeds observed with illuminating-gas mixtures were: Twenty inches per second or less with 8 per cent. gas; 5 feet or less with 11 per cent gas; from 10 feet to 13 feet with 16 per cent. gas. When the temperature of the gas mixture to be exploded was raised to 75 degrees Centigrade, the speed rose slightly in one case. With the poorer mixtures the initial temperature, 15 degrees or 75 degrees Centigrade, mattered little.

In the producer-gas mixtures of 30 per cent. the speed was about 20 inches per second, going down to half that value, or less, as the initial pressure was increased to 114 pounds per square inch. The producer-gas mixture of 46.5 per cent. gave a speed of 6½ feet or more. At the initial temperature of 15 degrees Centigrade it was, in the latter case, 6.4 feet, and at 75 degrees Centigrade, 6.9 feet per second.

Determinations of the calorific power of the coal gas—undiluted with air—in a Junkers calorimeter showed 483 B.t.u. per cubic foot; the producer gas showed 133 B.t.u. The 8 per cent. coal gas mixture would thus have had a value of 38.5 B.t.u., and the 30 per cent. producer gas mixture 39.9 B.t.u.; the two mixtures had therefore approximately the same calorific power, yet greater speeds were obtained in the producer gas, probably on account of its methane contents. Comparing the producer gas mixture of 46.5 per cent. with the coal gas of 16 per cent., the heat value of the former being about 61.8 B.t.u. and that of the latter 77.2 B.t.u., the experimenter found that the flame traveled at 13 feet per second in the coal gas, and only at 6½ feet in the producer gas mixture.

In discussing the results of these experiments, which will be continued, Dr. Nägel refers to the uncertainty of the temperature estimates. The first ignited-gas particles will be compressed after ignition, the last ignited particles will be compressed before being fired. The final temperatures will be very different, especially in gas-engine cylinders, which are of unsymmetrical shape.

The Fundamental Electrical Units

Ever since the international electrical congress held at the Columbian Exposition in Chicago fifteen years ago, physicists and scientists in practically all civilized countries have been considering the subject of electrical units and standards. There is no universally recognized practical unit of electromotive force, for example, although the so-called international volt has been in general use since its definition by the 1893 congress. Another international congress is to be held in London next month for the purpose of trying to agree on absolutely universal standard values for the ohm, volt and ampere, and it is to be hoped that the question will be settled for all time and on a rational basis.

It is proposed to make the ohm the first primary unit, adopting the present international standard of a column of mercury 106.3 centimeters high, of unvarying cross-section and weighing 14.4521 grams. It is further proposed to make the ampere also a primary unit, leaving the volt, the unit of pressure, a secondary or derived unit. While this plan may be the most expedient one it is not at all logical to treat a cause as secondary and its effect as primary, nor does it appear to be necessary in this case. Of course, there is the argument that a standard ampere is much more easily reproduced than a standard volt, but that is not a strong argument for a body of scientists to put forward. From all logical and rational considerations, the volt should be a primary unit. The Weston cadmium cell appears to be as reliable a means for getting at the standard volt as a silver voltameter is for obtaining the standard ampere. Neither standard unit can be picked up and used for purposes of comparison, like a standard yard or pound; the reproduction of either is a strictly laboratory process, and the fact that the one is a trifle easier to carry out than the other is not scientific justification for illogical definitions.

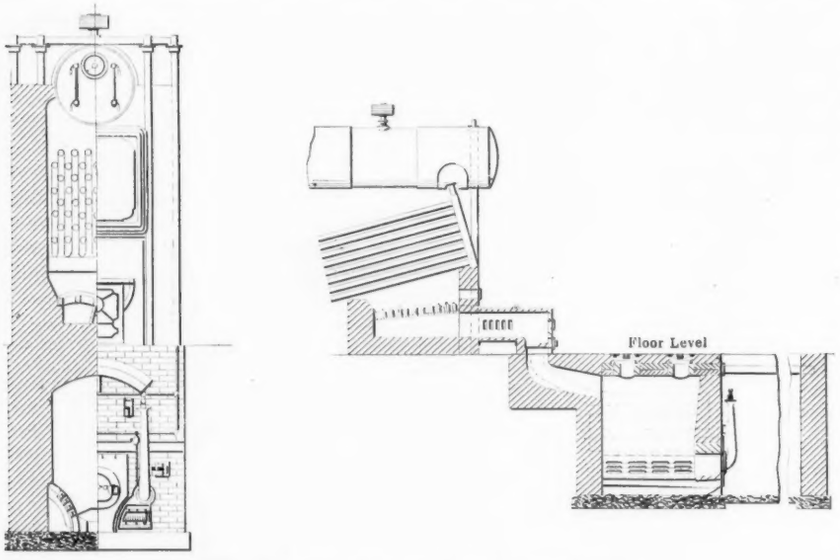
Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

Gas Producer System of Firing Steam Boilers

The main feature of this system of boiler firing is the application of a gas producer to the ordinary types of steam boilers. The illustration shows its application to a water-tube boiler.



FRONT AND SIDE VIEW OF GAS FIRING SYSTEM

The producer is placed in front of the boiler and is preferably sunk to a level with the floor, with the cleaning chamber in front. The fuel is put into the producer either direct or with a feeder. Cleaning is necessary once in twenty-four to forty-eight hours and steady steam pressure at all times is claimed. The combustion of the fuel is such that there is practically little or no smoke. Provision is made for shutting off the boiler at a moment's notice, and the whole arrangement is always under perfect control.

The fuel used may be gas, coke or coal, which is gasified in the producer in the usual way. Before entering the boiler, however, the gases and air are mixed in a chamber or chambers placed in front of the boiler, one to each firing door in the case of water-tube boilers. In the case of the Lancashire or Cornish boiler the gases pass into a combustion chamber constructed in the lower half of the flue or flues from which they issue through specially formed screens at a high temperature. It is evident that what was formerly the ash pit or receptacle for ashes is transformed into a reservoir of highly heated gases, thus considerably increasing the heating surface of the boiler.

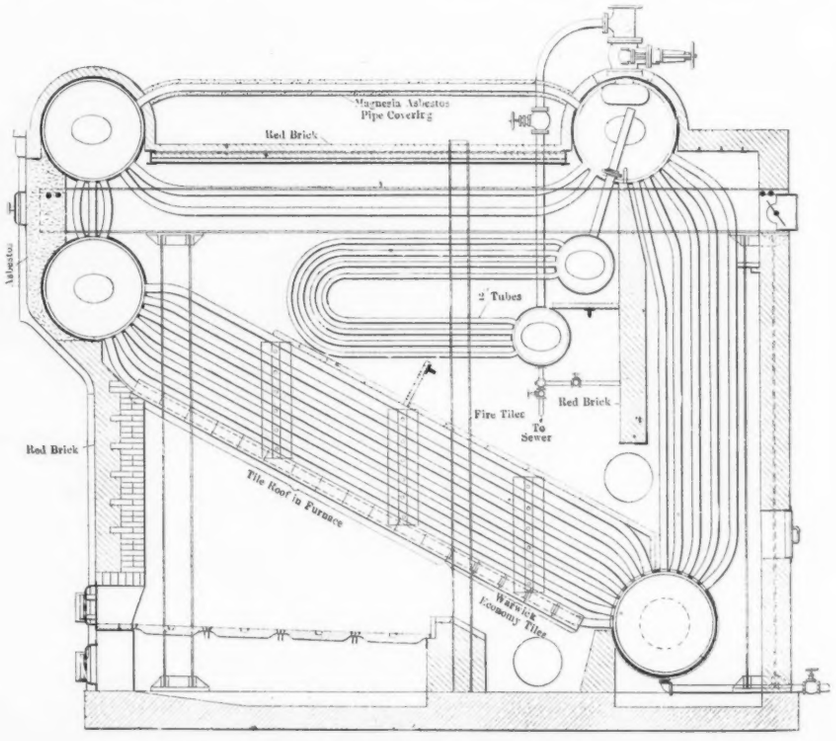
It is claimed that installations erected are effecting a surprising increase in evaporation per pound of fuel and at the same time giving very much greater evaporation per hour as compared with hand firing.

This system is manufactured by R. and G. Hislop, 13 St. James place, Paisley, England.

Badenhausen Water Tube Boiler

This type of water-tube boiler is manufactured by the Elliott Bay Iron Works, 318 Railroad avenue, Seattle, Wash., whose sales agents are the Engineering Corporation, 353 Arcade Annex, Seattle, Wash. It will be noted that the boiler combines the salient features of both the Babcock & Wilcox and Stirling boilers; that is, the circulation is practically the same as that of the Babcock & Wilcox boiler and the construction is that of the bent tubes such as are used in the construction of the Stirling boiler.

It is clear that the hot gases rise from the grate and pass up through the lower bank of tubes and, owing to the construction of the bafflewall, find their way toward the front of the boiler in their upward passage so that the two drums shown are utilized, in part, as heating surface. The two lower tube banks, passing from one upper drum to the



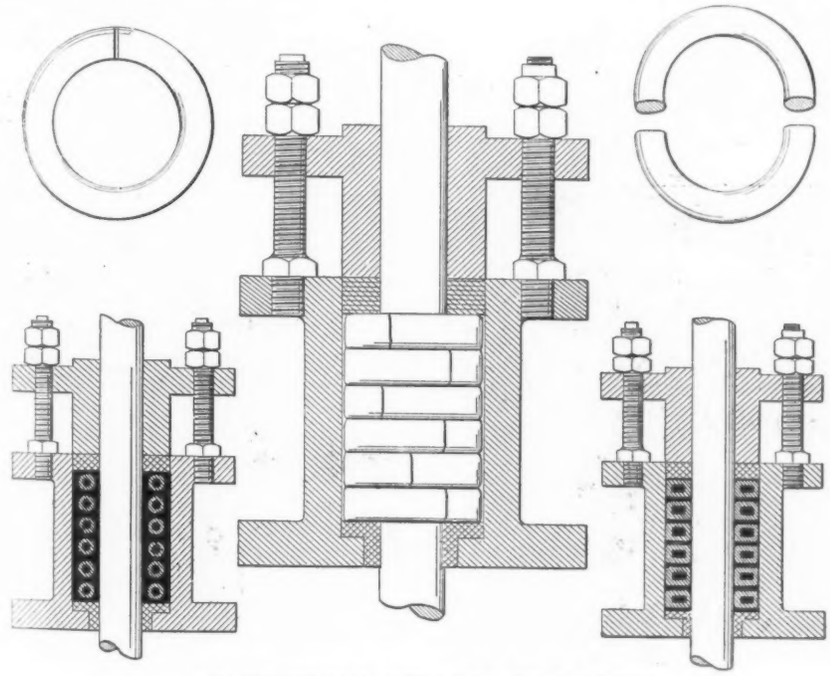
BADENHAUSEN WATER TUBE BOILER

other, are also in the passage of the hot gases, and, therefore, constitute part of the heating surface. The gases being deflected by the upper bafflewall pass down toward the rear end of the boiler, and in so doing give out part of their heat to the superheating coil shown. Striking the bafflewall in the rear, the gases pass down next to the mud drum, and in passing up toward the stack outlet surround the vertical tubes running from the mud drum to the upper steam drum.

Bach Metallic Packing Rings

The illustration shows the Bach metallic packing rings for stuffing boxes, which are said to have the following advantages: They may be immediately applied to any construction and are ready to insert in any size stuffing box, while the claim is made that they will last for years, as the contents of the rings do not escape. Owing to the antifriction features of this type of packing, it is claimed the piston rod does not wear, and considerable time is saved for the engineer because the rings do not require replacing at frequent intervals. The adherence of the metal packing rings, which are filled with graphite, to the stuffing box through excessive heat is impossible.

This type of metal packing ring is suitable for steam engines for all industrial purposes, high-pressure steam engines up to 360 degrees Centigrade, steam



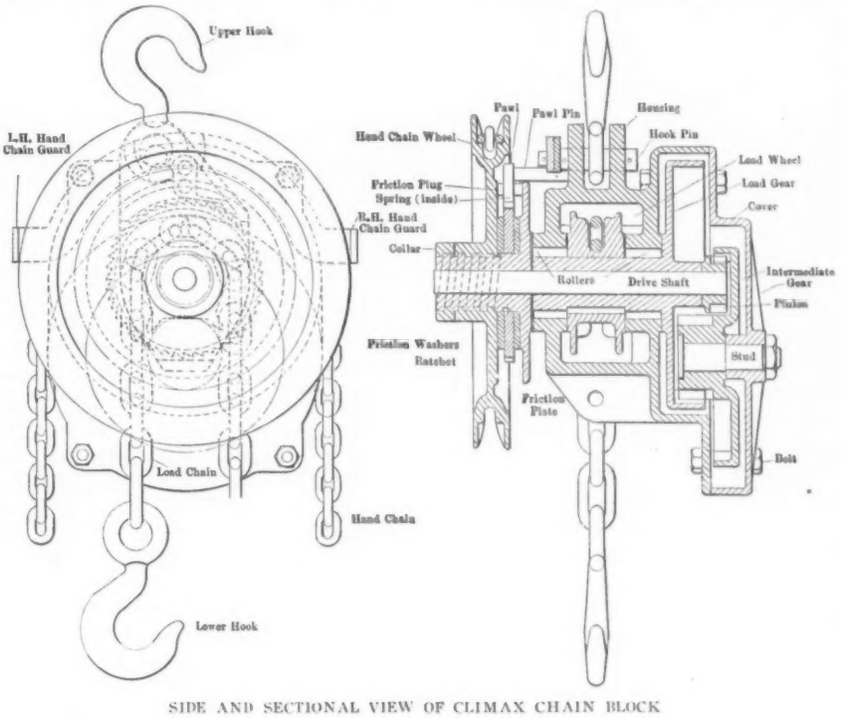
BACH METALLIC PACKING IN STUFFING BOXES

hammers, cold and hot-water pumps, and particularly pumps for sugar factories, air compressors, carbonic-gas acid engines, hydraulic engines of all kinds for water works, locomotives and for motor-vehicle use. The packing is manufactured by Markus M. Bach, Charlottenburg, Leibeniz-Strasse 28, Berlin.

Climax Spur Geared Chain Block

A spur-geared chain block of special design and manufactured by the Climax Hoist Company, 1753-55 N. Howard street, Philadelphia, Penn., is shown in detail in the accompanying illustration.

The load chain runs on a sprocket wheel keyed to a long hub or sleeve supported in a housing, and cast in one piece with an internal load gear. This gear is driven by a spur pinion carried on a stud, the pinion being in one piece with an internal gear, and driven in turn by a spur pinion carried on the hand-chain wheel shaft which passes through the hub of the load gear to the opposite side of the block where the hand-chain wheel is located. Hoisting is accomplished by pulling on the right-hand side of the hand chain, thereby rotating the mechanism. Lowering is done by pulling on the left-hand side of the hand chain, which releases the friction brake and permits the load to descend.



SIDE AND SECTIONAL VIEW OF CLIMAX CHAIN BLOCK

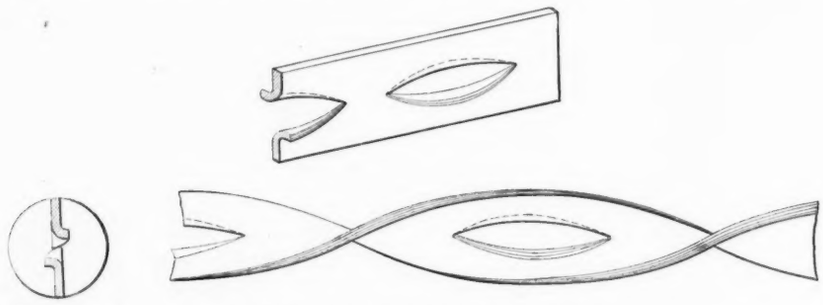
The load is carried on hardened and ground steel rollers, which, it is claimed, give an efficiency of more than 80 per cent. The gears are all inclosed in a dust-proof case and run in an oil bath. Owing to the few parts and simplicity of construction, the cost for repairs should be small. The retaining brake is extra strong, and smooth and noiseless in operation. The chains are made of high-grade iron.

Firebrick Shapes

The Baltimore Retort and Fire Brick Company, Hull and Nicholson streets, Baltimore, Md., manufactures firebrick and firebrick shapes of all conceivable forms. The regular brand is intended especially for use where ability to withstand extremely high temperature is desired. The company's patent bond brick have concavities on one side and buttons to match on the other, constituting an interlocking feature to prevent their giving way. They are used for tying in a wall where there is a liability of strain.

Internal Bond Bar for Concrete Reinforcement

The illustration shows the construction of a new internal bond bar for concrete reinforcement, patented by Arthur Priddle, Builders' Exchange building, San Francisco, Cal. Its main features consist of the flanged slit in the center of the flat side of a rectangular section bar, the preferred form; as the section is not reduced the strength is not impaired. The bars are made in small and large sizes; the smaller sizes are made cold, the larger sizes made hot. A fabric can be made by weaving small bars of the same pattern through the apertures. The flanges on the bar overcome the cutting effect of a flat bar when used plain. It is evident that the bar can be turned on its axis for any special position.



BOND BAR FOR REINFORCING CONCRETE

Copes Boiler Feed Regulator and Pump Governor

The purpose of this apparatus is to maintain a constant water level in steam boilers. The construction is simple; the longitudinal expansion of a straight composition metal tube, caused by changes in temperature, furnishing the force by which a check valve in the feed line is operated. Fig. 1 shows the expansion tube with the piping necessary to connect it to the water column and check valve.

When the water in the boiler is above the desired level the disk of the check valve is held to its seat by a weight *C*, Fig. 2, acting through a toggle joint. When the water level falls, steam enters the expansion tube and the expansion of the latter operates through a bell-crank lever *B* to raise the weight and release the check valve, permitting water to pass into the boiler.

Fig. 3 illustrates the pump governor in section. This consists of a throttling valve placed in the steam line and controlled by a piston on the valve-stem. The pressure of water from the pump discharge acts upon one side of this piston, tending to close the valve, while the steam pressure from the boiler acts on the other side, tending to open the valve. A counterweight is so adjusted that the valve will just seat when the feed-line pressure is at a pre-determined excess over the boiler pressure.

If, for instance, there are three boilers in the battery and it is desired to carry a pressure of 20 pounds more in the feed line than in the boilers, the controlling valve of the governor will pass steam to the pump as long as the feed-line pressure is less than 20 pounds above boiler pressure. On the other hand, when the feed-line pressure tends to rise above this excess, its action on top of the piston overcomes the sum of the steam pressure and the counterweight and cuts off the steam from the pump until the pump-discharge line pressure is reduced by some boiler taking water.

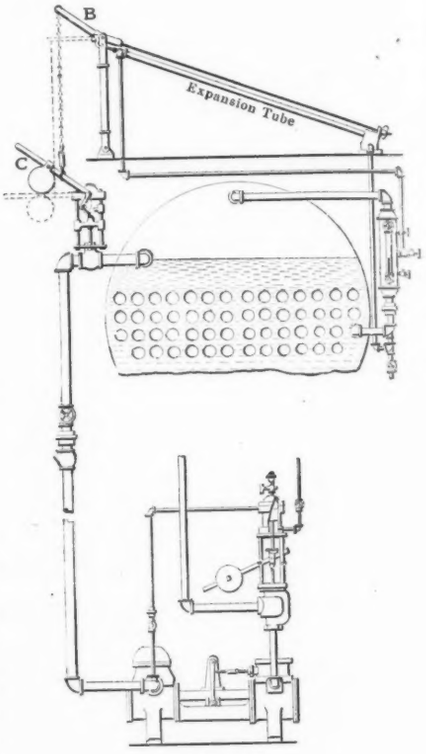


FIG. 2

This regulator and governor is manufactured by the American Boiler Economy Company, Philadelphia, Penn.

Twenty common brick, laid, equal one cubic foot.

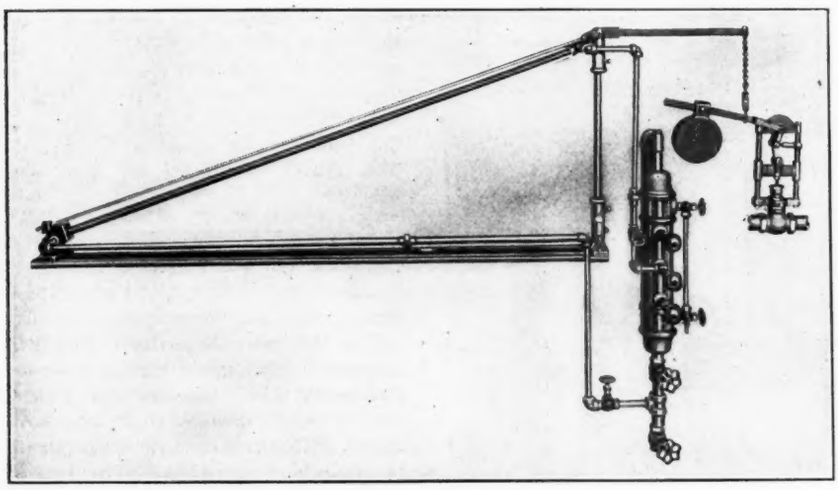


FIG. 1. SHOWING EXPANSION TUBE AND CONNECTIONS

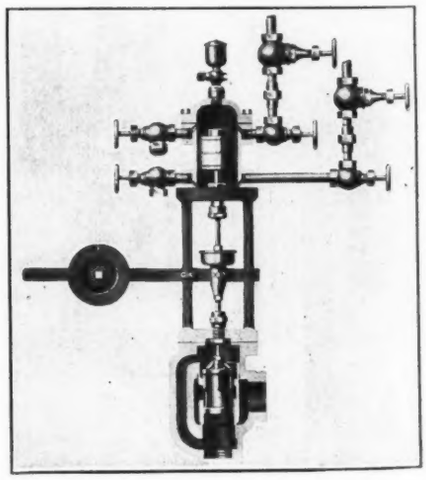


FIG. 3. SECTIONAL VIEW OF PUMP GOVERNOR

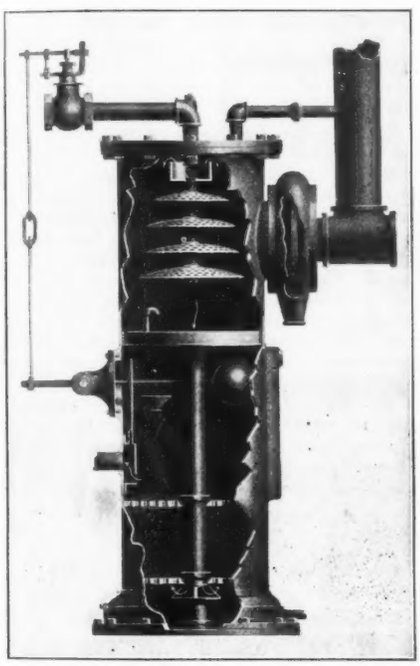
Immediately upon entering the boiler room ascertain, beyond a doubt, whether the water in the boiler is at the proper level.

New Open Feed Water Heater

A new form of open feed-water heater has been devised by The Sims Company, Erie, Penn. It is constructed of cast iron and is round in form, with all flanges surfaced.

Instead of the usual trays for gathering scale-producing matter, this heater has inverted perforated saucers suspended from a central hook bolt which maintains this interior structure always plumb, giving an even flow and perfect distribution of the water.

The water passes through an automatic valve controlled by a float in the water chamber, and overflows from a cast-iron cup which forms a trap, thus preventing steam from going into the water line, after which the water, passing through the perforations, is distributed in proper



SIMS NEW OPEN FEED WATER HEATER

form to absorb every possible unit of heat. If the perforations should at any time become clogged the water will still be well distributed as it will leave the saucers as a thin veil at the outer edges.

From these inverted saucers the water flows into a receiving tray; between this tray and the inner shell of the heater is a packing and the water must therefore necessarily flow down the pipe into the mud chamber, as indicated by the arrows, where a large per cent. of the impurities will precipitate by its own gravity. The filter, not being loaded with this heavy matter as when filtration is downward, is in fine condition to remove the lighter particles which are frequently the more troublesome. The water ascending through this body of hard coke held in suspension between two grates is very thoroughly filtered.

A surface blow-off is provided, also a trap over the water outlet to the pump. This trap prevents any scum that may be floating on the surface of the water from reaching the feed-line if the water in the heater should become lower than the working level; this provision causes the suction to the pump to break before the surface of the water can be drawn down sufficiently low to pass through the trap. A vent is also provided in the receiving tray to prevent the danger of the water being "air bound."

With this method of filtering upward, whenever the mud is blown out of the chamber in the bottom of the heater there will be a rush of water through the filter, tending to clean it. The heater is also supplied with suitable clean-out doors, water gage, etc.

The illustration shows the heater piped for the induction method. With this method the heater receives all the steam that it can possibly absorb and no water is carried out with the steam. These heaters are made in sizes from 50 horsepower and upward.

New Goetze Gaskets and Valve Disks

Fig. 1 of the accompanying illustrations shows a gasket composed of copper, asbestos and graphite, which has been brought out by the American Goetze Gasket and Packing Company, of New York City. It consists of a plain profiled copper gasket inlaid with asbestos-graphite, and it is claimed that it will make the most obstinate joint tight. As a substitute for flexible valve disks hitherto used, a gasket or disk has been devised, which is applied as shown in Fig. 2. All standard sizes for various designs of valves by various manufacturers are made and kept in stock.

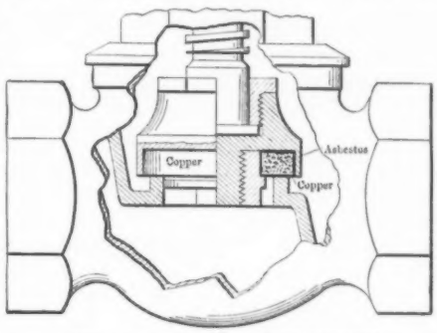


FIG. 2. GOETZE'S VALVE GASKET

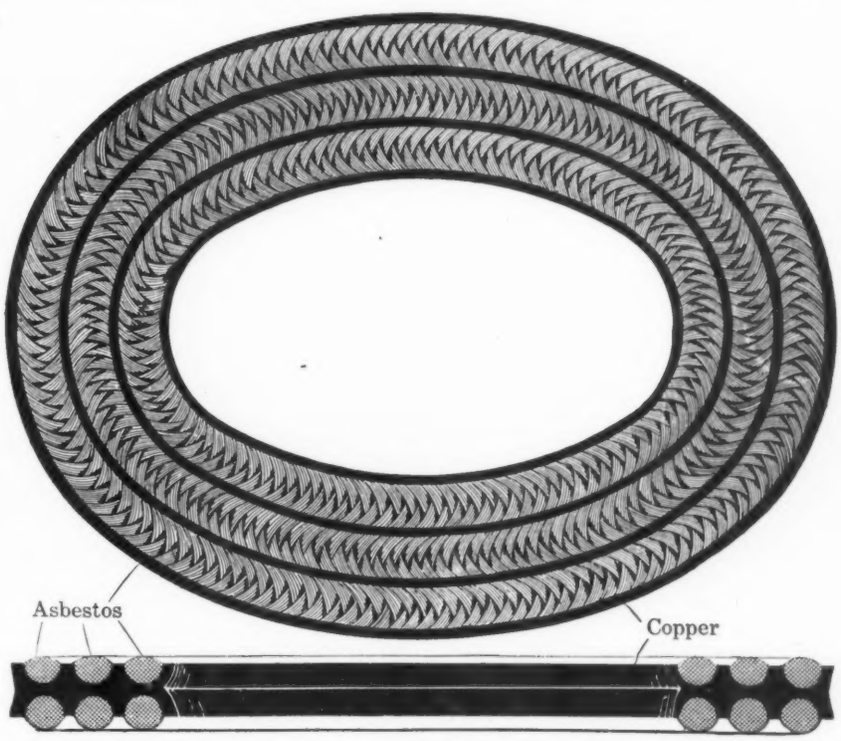


FIG. 1. GOETZE'S COPPER MANHOLE GASKET

Books Received

"High Speed Dynamo Electric Machinery." By H. M. Hobart and A. G. Ellis. John Wiley & Sons, New York. Cloth; 526 pages, 6x9 inches; 355 illustrations; indexed. Price, $6.

"Hydro-Electric Practice." By H. A. C. E. Von Schon. J. B. Lippincott Company, Philadelphia, Penn. Cloth; 382 pages, 7¼x9¾ inches; 140 illustrations; indexed. Price, $6.

"The Water Powers of Wisconsin." By Leonard S. Smith. Wisconsin Geological and Natural History Survey, Madison, Wis. Cloth; 354 pages, 6½x9½ inches; illustrated; indexed; tables. Price, 25 cents to cover payment of postage.

Inquiries

Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

The Four-stroke Cycle

Who really originated the four-stroke cycle now commonly employed in gas engines?

M. K. K.

Beau de Rochas first announced the principles of the cycle; Otto built the first engine in which it was completely carried out.

Circular Mils

What is meant by the expression "circular mils" as applied to electric-light wires?

M. W. S.

The circular mil is the unit used as a basis for the calculation of the cross-sectional area of wires. The cross-section, in circular mils, of any wire is equal to the square of its diameter in mils. A mil is 1/1000 inch.

Temperature of Boiling Water Underground

Will the boiling point of water be higher in a mine several hundred feet deep than at the sea level?

F. A. C.

The temperature at which water boils depends upon the pressure upon its surface. At a depth of 500 feet below the sea level the boiling point would be 213 degrees; at 2000 feet, 215 degrees and at 4000 feet, 217 degrees.

Factor of Safety

What is meant by the expression "factor of safety?"

J. A.

The factor of safety is the ratio of the strength of a material to the maximum load put on it. In Massachusetts the factor of safety of boilers is fixed by law at 5; that is, the load allowed upon a boiler is limited to one-fifth its ultimate strength; or, more logically, the strength of a boiler (in its weakest part, of course) must be five times the maximum pressure to which it is to be subjected.

Lost Motion in Pump Valve Gear

For what purpose is there lost motion between the block and the valve of a duplex pump, and how much lost motion should there be?

By lost motion is meant the distance the valve rod travels before moving the valve. The object of this lost motion is to allow one piston to nearly complete its stroke before starting the valve controlling the other. As one piston approaches the end of its stroke, it moves the valve enough to allow the second piston to take up the work as the first one lays it down. The amount of lost motion should be just enough to allow each piston to travel full stroke. In pumps where this lost motion is not adjustable it is usually made equal to one-half the width of the steam port.

Unsymmetrical Armature Setting

The armature of a 40-horsepower multipolar electric motor runs over toward one side of the machine to such a degree that the rubbing of the collar on the shaft against the end of the journal bushing heats it. What is the cause?

H. J. P.

If the machine sets level, the armature is not centered in the field-magnet and the pull of the magnet poles drags it over against the box. The remedy is to move that journal box out farther from the frame and move the other one inward a corresponding distance. The distance required can be determined by a few experiments; set the boxes over ⅛ inch and run the machine free for a few minutes; if the collar still rubs, set the boxes over ⅛ inch more, and so on until the armature "floats" freely endwise.

Perfect Gases

What is a "perfect" gas and for what purposes are perfect gases used?

T. A. G.

There is no perfect gas in existence, so far as physicists have been able to discover. A perfect gas, if it existed, would follow exactly the laws expressed in the formula

$$\frac{Pressure \times Volume}{Temperature} = 778 \times (C_p - C_v),$$

in which C_p represents specific heat at constant pressure and C_v the specific heat at constant volume. The pressure and temperature are expressed in absolute values, and English units are to be used, as the formula is stated.

The elementary gases and their common chemical combinations approach so nearly to what perfect gases would do that they are considered as such for convenience in making calculations.

Babbitting a Journal Box

1. How can I tell when melted babbitt metal is hot enough to pour?

2. Is it necessary to drill holes or chip slots in the box to keep the lining from working out?

3. Will babbitt metal stick to an ordinary shaft if it is not oiled?

F. J. L.

1. When the melted metal will char a pine stick thrust into it, it will pour well.

2. As the metal will not unite with or stick to the box some provision must be made to keep it in place. In ordinary shafting boxes there is usually a ledge cast on the ends and sides of the box which serves to hold the metal in place. In connecting-rod ends and the main bearings of engines it is better that the metal be thoroughly hammered until it fits the inside of the box perfectly and then bored to the right size.

3. If the shaft is perfectly clean the metal will sometimes give anoyance by sticking. It is a good practice to give the shaft a coat of oil or graphite, or in some cases wrap it with a sheet of paper.

Business Items

Recent orders taken by the Ohio Blower Company, Cleveland, Ohio, include 18 cast-iron exhaust heads from 5 to 16 inches, and 13 "Swartwout" steam separators from 6 to 10 inches.

Kellogg & Buck, Morenci, Mich., who operate the Morenci roller mills, installed a Buckeye boiler skimmer made by the Buckeye Boiler Skimmer Company, South End, Toledo, Ohio, in one of their boilers and after a thorough trial say it has kept the boiler clean and upheld every claim made for it.

The Russell Engine Company, of Massillon, Ohio, has moved its St. Louis office from the Victoria building to 208 Security building. This office is in charge of J. B. Bell, who is a well known engineer in that section. The Russell Engine Company, in addition to building its well known line of engines, installs complete steam plants, vacuum heating and ventilating systems.

The complete equipment of the new power house for the Warrenton Woolen Company, Torrington, Conn., will consist of three 72-inch Bigelow horizontal return-tubular boilers, a feed-water heater and an auxiliary heater arranged for connection to a future economizer, a 19x36 Cooper-Corliss horizontal simple non-condensing engine, direct connected to 250-kw. Crocker-Wheeler alternating-current generator. No piping will appear in the engine room, all steam being taken from below the floor. The economizer when installed will heat water for manufacturing purposes, a tank being provided in the dye house and the system so arranged that the water will circulate through the economizer and be stored in the tank.

New Equipment

The Mitchell (S. D.) Power Company has plans finished for a new power house.

F. A. Howe, Jr., Huntsville, Ala., will establish an electric plant at Gurley.

Armour & Co., of Chicago, Ill., will establish a phosphate plant at Phosphoria, Fla.

Parker, Webb & Co., Detroit, Mich., is having plans prepared for a new packing house.

Ruddy Bros., Kansas City, Mo., will establish a cold storage and ice plant to cost $300,000.

F. Largen, Floresville, Texas, has applied for a franchise to construct an electric-light plant.

Capitol Brewing and Ice Company, Montgomery, Ala., will rebuild its plant recently burned.

A new dye-house will be erected for the Cleveland Worsted Mills Company at Ravenna, Ohio.

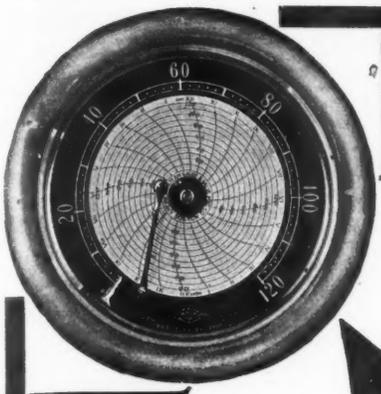
The city of Sevierville, Tenn., contemplates installing a gasolene plant for lighting. C. W. Fox, recorder.

The Poplarville (Miss.) Light and Water Company will make improvements to cost about $10,000.

Ludwig Sellmayer, Baltimore, Md., has awarded contract for erection of a two-story cold-storage plant.

The Chatfield (Minn.) Electric Light and Power Company contemplates erecting an auxiliary power house.

Bids will be received until September 24 by the town clerk, Hartley, Iowa, for installing an electric-light plant.



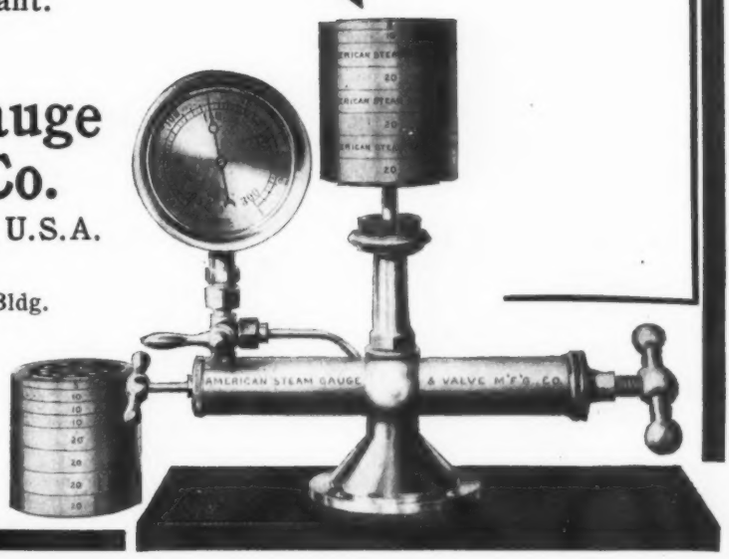
The American Combined Pressure and Recording Gauge

Keeps an accurate account of the pressure in boilers day and night. It immediately shows the way to 10% fuel saving, and can always be depended upon for perfect reliability. Circular 3-D.

"AMERICAN" PRODUCTS

The American Dead Weight Gauge Tester

tests steam gauges by dead weights and shows at once whether or not they are registering correctly. It is invaluable in any power plant. Circular 4-D.



American Steam Gauge and Valve M'f'g Co.

208-220 Camden St., Boston, Mass., U.S.A.

New York, 26 Cortlandt St.

Atlanta, 835 Equitable Bldg.

Chicago, 7-9 So. Jefferson St.

Pittsburg, Frick Bldg. Annex.
San Francisco, 247 Pine St.
Montreal, 444 St. James St.
Los Angeles, 213 So. Los Angeles St.

The citizens of St. Mary's, Kans., have voted to issue $15,000 bonds for an electric-light plant. Henry Mees, city clerk.

H. V. Burns, 4 Library Row, Augusta, Ga., is interested in the organization of a company to establish an ice plant.

City of Corpus Christi, Texas, will vote on issuance of $125,000 bonds to purchase and enlarge its water-works plant.

Contract for addition to power house at the mill of the American Velvet Company, Stonington, Conn., has been awarded.

The city of Pryor Creek, Okla., contemplates installing water-works system. F. M. Watts, Pryor Creek, should be addressed.

Poenish Bros., Wichita, Kans., owners of the Banner Mills, recently destroyed by fire, have made arrangements to rebuild.

The Jewell Cotton Mills, Charlotte, N. C., recently organized, will commence construction of buildings soon. T. J. Lillard is treasurer.

The Southern Colorado Power and Railway Company, Trinidad, Colo., is contemplating installing new boilers and a turbo-generator.

The Parker Hosiery Mills and Dye Works, Portsmouth, Va., will erect new buildings to replace the present ones. Will use electricity.

The city of Danville, Va., has appropriated $22,000 for a central lighting plant. Frank Talbot, superintendent Water, Gas and Electric Department.

The Austin Run Mining Company, Harrison building, Philadelphia, Penn., is said to be planning to install a power plant at its mine at Brooke, Va.

Bids will be received until 7 p.m., September 24, by L. E. Weber, secretary Board of Public Service, Minerva, Ohio, for a 150-horsepower boiler of 150 pounds steam pressure.

The Zanesville & Meigs Valley Traction Company has been organized to construct an electric railway from Zanesville to Beverly, Ohio. E. R. Meyer, Zanesville, Ohio, president.

The Greenesville Light and Water Company is planning to begin construction of a water-power electric plant near Emporia, Va. W. S. Goodwyn, Emporia, is president.

It is reported that bids will be received about Nov. 1 for the contruction of water works at Mesa, Ariz., to cost about $50,000. L. G. Knipe, Phœnix, Ariz., is engineer.

A company has been organized at Sweetwater, Texas, to construct a water, ice, light and power plant. Burns & McDonnell, Dwight building, Kansas City, Mo., will supervise the work.

The Electric Light and Street Car Company, St. Petersburg, Fla., will build an addition and install new machinery at a cost of about $15,000, including Corliss engine, boiler and dynamo.

It is reported that a company is being organized at Fairburn, Ga., to build an electric street railway from Fairburn to College Park. Dr. L. M. Hobgood, Fairburn, is interested.

The Oklahoma, Missouri & Kansas Interurban Railway Company has been organized at Miami, Okla., to build a railroad from Miami to Lincolnville. Capital $100,000. President, Franklin Smith, Joplin, Mo.

Proposals will be received until noon Sept. 19 for a power plant at the Ohio Soldiers and Sailors Orphans Home, at Xenia, Ohio, according to plans, etc., on file in the office of superintendent of the home.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., October 5, for duplex horizontal feed pump, rotary hand pumps, gage glasses, rubber gage glass gaskets, etc., as per Circular No. 166.

Bids will be received until September 30 by C. W. Goodman, superintendent Indian School, Phoenix, Ariz., for installing two 125-horsepower boilers, two oil pumps, feed-water heater, duplex steam pump, electric motor.

The Huntsville, Chattanooga & Birmingham Interurban Railway, Light and Power Company has been incorporated at Huntsville, Ala., with $50,000 capital. The company will build a railroad from Huntsville to the State Fair Grounds. Ed. L. Pulley, general manager.

The Albany & Hudson Railroad Company, operating an electric railroad is planning improvements at its power house in Hudson, N. Y., including the installation of a new steam turbine and motor generator, also the erection of a new boiler house.

The minority stockholders of the Barre and Montpeller Street Railway Company objected to the power house plans of the majority and for that reason the Corry-Deavitt-Frost Electric Company, was incorporated at Montpelier, Vt., with $150,000 capital to build a $100,000 power plant in the east part of the city on Winooski river.

New Catalogs

Fort Wayne Electric Works, Fort Wayne, Ind. Bulletin No. 1111. Motor drives. Illustrated, 24 pages, 8x11 inches.

Goulds Manufacturing Company, Seneca Falls, N. Y. Booklet. Hand and power pumps. Illustrated, 3½x6 inches.

Nernst Lamp Company, Pittsburg, Penn. Bulletin A. Westinghouse Nernst lamp. Illustrated, 30 pages, 4½x6 inches.

Standard Temperature Regulation Company, 90 West street, New York. Catalog. Hot water regulator. Illustrated, 20 pages, 6x9 inches.

Central Station Steam Company, Detroit, Mich. Catalog No. 2. Theory and practice of the Detroit meter. Illustrated, 12 pages, 6x9 inches.

Anchor Packing Company, Philadelphia, Penn. Catalog C. Fibrous packings. Illustrated, 46 pages, 4x6½ inches. Circular. Tauril sheet packings.

Oscar Barnett Foundry Company, Hamilton and Bruen streets, Newark, N. J. Catalog. "The Universal" stoker. Illustrated, 8 pages, 6x9 inches.

Gem Manufacturing Company, Pittsburg, Penn. Catalog No. 5. Oilers, torches, flexible shafting, boiler tube cleaners, etc. Illustrated, 42 pages, 6x9 inches.

The Triumph Electric Company, Cincinnati, O. Pamphlet. "The Way to Forget." A Treatise on Traveling without Stop-over. Simple Life in the Private Office.

Buffalo Forge Company, Buffalo, N. Y. Catalog 97. Air washer and humidifier. Illustrated, 36 pages, 6x9 inches. Catalog No. 7. Oil and lubricating devices and treatise on "How to Oil an Engine." Illustrated, 96 pages, 6x9 inches.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

STEAM ENGINE ERECTING ENGINEER, capable of assisting in sales department, young man with shop experience and wide acquaintance among New England engineers preferred. Box 33, POWER.

NOTICE TO ENGINEERS—If you are desirous of making a change we offer the best opportunity for a nice income to the right man. The best selling specialty for a boiler extant. Selling for $50.00 each. A necessity for every boiler. Liberal contract. Address Power Specialty Co., 236-A. Fort St. W., Detroit, Mich.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

CHIEF ENGINEER of large industrial plant desires change; active and alive, an expert with indicators and testing apparatus, can keep operating expenses at proper figures. Box 27, POWER.

WANT POSITION as engineer. Age 31; 16 years' experience in steam engineering; low and high speed and Corliss engine, pumps and boilers; a.c. and d.c. generators and air compressors. Married, strictly sober; will come on 30 days' trial. Employed at present. "J. C. F.," POWER.

ELECTRICAL ENGINEER, 12 years' experience, installing, operating and repairing engines, turbines and electrical machinery. Technical education, indicator, first-class license, A-1 reference. Box 42, POWER.

POSITION WANTED in Southern States of America or Mexico by a wide awake operating engineer of three years' technical and long practical experience, who is thoroughly competent to operate and maintain plant and machinery of any description and get maximum results. Wishes position where close application and merit will be appreciated. At present chief engineer and master mechanic of a 100-ton plate and 30-ton can ice plant. "P. F.," POWER.

WITH SEVEN YEARS' experience from shop to electrical engineer in charge of machinery and equipment of a railway light and power system, graduate mechanical engineer desires change. Box 40, POWER.

A POSITION in any kind of engineering work by a 1907 graduate from the University of Michigan in mechanical engineering. Address C. L. Tuttle, Hammondsport, N. Y.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

WANTED—Patented articles which can be used in machine shop, boiler room or engine room. Must have merit. We possess finest facilities for marketing, having a large force of traveling men in this country and agents in nearly every large city of Europe, who call upon steam users and machine shops. Liberal contract. Highest of references. Address Power Specialty Co., 236-A. Fort St. W., Detroit, Mich.

STIRLING BOILER TUBES, cracking off can stop at once or no pay. Wm. Fulton Engineering Co., office, 28 N. Canal St., Dayton, Ohio.

For Sale

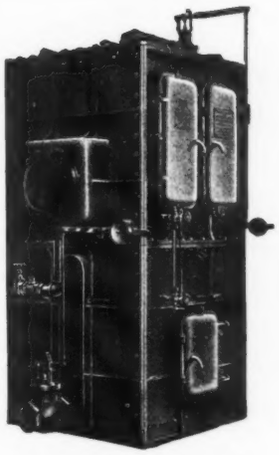
Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Two 60"x16' H. T. boilers; two 52"x16' H. T. boilers; one 8"x10", 125 R. P. M., Imperial engine, direct connected to 25 kw., 125 V., direct current Triumph generator; one 7"x8", 375 R. P. M., direct connected to 10 kw., 125 V., direct current generator; one 20 H.P., 500 V. Edison motor; one 7½ H.P., one 3 H.P., and one ½ H.P., 500 V. direct current General Electric motor. Address Thompson Hotel Company, Lincoln, Neb.

FOR SALE—Patent right for a reversible-non-reversible rotary engine; steam consumption less than Corliss engines. Box 41, POWER.

STEAM PLANT FOR SALE—22x48 Wetherill Corliss engine. Cost $3350; sell $1500. Two tubular boilers, 66"x18'. Cost $1000 each; sell $450 each. F. O. B. cars Chester, Pa. All in good condition. Keppel & Co., Chester, Pa.



Webster Feed Water Heater.

"It's Not The Money, It's The Principle Of The Thing"

That Counts When You Are Buying Feed Water Heaters

The *cost* of a feed water heater, purifier and filter is not the important consideration. It's the *principle* on which it works that should interest you most because it's there the economy and efficiency are started.

The Webster is an open heater that automatically uses just enough exhaust steam to heat the water to the highest point. It is *not* a thoroughfare for the exhaust, and it allows no back-pressure on the engine. Every Webster Heater is built to meet the specific requirements of the water it is to treat and the plant that is to use it. Every Webster Heater is guaranteed to do its work with perfect satisfaction.

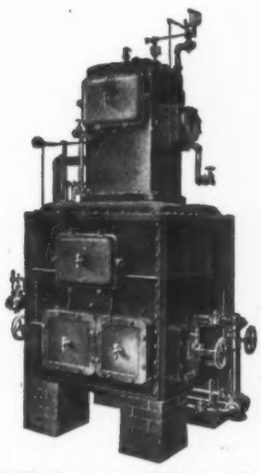
Let us tell you the details of principle, construction and operation of Webster Heaters. You out to be getting the coal and water saving that comes to "Websterites."

For Free Descriptive Booklet 12-F, Address

Warren Webster & Co.

Camden, N. J.

U.S.A.



Webster Chemical Purifier. 12

Alphabetical Index to Advertisers

	PAGE
Alberger Co., A. H	109
Alberger Condenser Co	103
Allan & Son, A	109
American Boiler Economy Co	106
American District Steam Co	92
American Engine Co	113
American Goetze-Gasket and Packing Co	77
American Injector Co	67
American School of Correspondence	71
American Steam Gauge and Valve Mfg. Co	55
American Steam Pump Co	100
Anchor Packing Co	73
Anderson Co., V. D	96
Armstrong Mfg. Co	89
Ashton Valve Co	89
Automatic Safety Water Gauge Co	89
Babcock & Wilcox Co	103
Ball-Cooley Engineering Co	109
Ball Engine Co	111
Baragwanath & Son, Wm	102
Barnes Co., W. F. & Jno	61
Bartlett & Snow Co., C. O	92
Bates Machine Co	96 and 111
Beggs & Co., Jas	93
Berry Engineering Co	106
Bignall & Keeler Mfg. Co	91
Binghamton Boiler Compound Co	67
Bird-Archer Co	1
Borden Co	90
Brandt, Randolph	78
Bristol Co	116
Broomell, Schmidt & Steacy Co	108
Brown Engine Co., C. H	110
Buckeye Boiler Skimmer Co	67
Buckeye Engine Co	112
Burt Mfg. Co	10
Cancos Mfg. Co	70
Canfield Mfg. Co	70
Carey Co., Philip	65
Central Station Steam Co	100
Chaplin-Fulton Mfg. Co	105
Chesterton Co., A. W	78
Clark Bros. Co	112
Climax Smoke Preventer Co	92
Cling-Surface Co	63
Cook's Sons, Adam	82
Cooper Co., C. & G	111
C-O-Two Furnace Co	92
Crocker-Wheeler Co	106
Crosby Steam Gage & Valve Co	61
Curtis & Curtis Co	89
Davis Regulator Co., G. M	87
Dean Bros. Steam Pump Works	103
Dearborn Drug & Chemical Wks	5
De Laval Steam Turbine Co	110
De La Vergne Machine Co	109
Deming Co	100
d'Este Co., Julian	96
Detroit Leather Specialty Co	61
Detroit Lubricator Co	83
Diamond Rubber Co	76
Direct Separator Co	92
Dixon Crucible Co., Jos	82
Du Bois Iron Works	61
Eclipse Feed Water Heater & Purifier Co	100
Edge Moor Iron Co	104
Erie Mfg. and Supply Co	112
Eureka Packing Co	75
Fisher Governor Co	105
Fitchburg Steam Engine Co	110
Foos Gas Engine Co	108
Fort Wayne Electric Works	107
Franklin Boiler Works Co	104
Gardner Governor and Separator Co	93
Garlock Packing Co	9
General Electric Co	113
General Specialty Co	78
Goubert Mfg. Co	93
Goulds Mfg. Co	100
Green Engineering Co	92
Green Fuel Economizer Co	98
Greene, Tweed & Co	82 and 116
Griffith & Wedge Co	109
Griscom-Spencer Co	99
Hammel Oil Burner Co	92
Harrisburg Pipe and Pipe Bending Co	99
Harrison Safety Boiler Works	59
Hawk-Eye Compound Co	67
Heine Safety Boiler Co	103
Hershey Machine and Foundry Co	92
Hill Publishing Co.,	68, 70 and 94
Hoffman, Geo. W	109
Homestead Valve Mfg. Co	84
Hoppes Mfg. Co	97
Houchin-Aiken Co	77
Huyette Co., Paul B	90
International Correspondence Schools	81
Jeffrey Mfg. Co	93
Jenkins Bros	86
Johns-Manville Co., H. W	69
Johnson Co., Henry	77
Keeler Co., E	104
Kewanee Boiler Co	104
Keystone Lubricating Co.,	3 and 115
Kitts Mfg. Co	95
Lagonda Mfg. Co	80
Lammert & Mann	106
Leavitt Machine Co	89
Liberty Mfg. Co	79
Lippincott Steam Specialty & Supply Co	61
Loew Mfg. Co	98
Lunkenheimer Co	85
McClave-Brooks Co	7
McCrea & Co., James	90
McGowan Co., Jno. H	103
McLeod & Henry Co	91
Martin Grate Co	92
Mason Regulator Co	89
Mayville Specialty Mfg. Co	92
Mercer Rubber Co	77
Minneapolis Steel & Machinery Co	114
Monarch Steam Blower Co	78
Morehead Mfg. Co	96
Morrin Climax Boiler Co	103
Mound Tool and Scraper Co	109
Murphy Iron Works	92
Myers & Bro., F. E	100
National India Rubber Co	77
National Pipe Bending Co	99
National Tube Co	90
Neemes Bros	90
New York Belting and Packing Co., Ltd	74
Northern Electrical Mfg. Co	109
Ohio Blower Co	93
Ohio Brass Co	89
Ohio Injector Co	67
Oil Well Supply Co	105
Oster Mfg. Co	61
Parker Boiler Co	104
Patterson & Co., Frank L	99
Peerless Rubber Mfg. Co	72
Penberthy Injector Co	8
Pennsylvania Flexible Metallic Tubing Co	77
Philadelphia Lubricator and Mfg. Co	83
Phosphor Bronze Smelting Co., Ltd	67
Pierce Co., Wm. B	2
Pittsburgh Gage & Supply Co	87
Pittsburgh Valve and Fittings Co	88
Pittsburgh Valve, Foundry and Construction Co	88
Platt & Co., Jno	96
Power Specialty Co	104
Presbrey Fire Brick Works	91
Providence Engr. Works	109
Quaker City Rubber Co	4
Randle Machinery Co	106
Reliance Gauge Column Co	95
Restein Co., Clement	71
Rhoads & Son, J. E	84
Ridgway Dynamo and Engine Co	110
Riverside Engine Co	108
Robb-Mumford Boiler Co	105
Robertson & Sons, Jas. L	75
Robins New Conveyor Co	84
Rust Boiler Co	104
St. John, G. C	96
Saginaw Mfg. Co	84
Schutte & Koerting Co	101
Shepherd Engineering Co	109
Shultz Belting Co	83
Sirocco Engineering Co	92
Skinner Engine Co	112
Smooth-On Mfg. Co	6
Southwark Foundry and Machine Co	110
Starrett Co., L. S	116
Steel Mill Packing Co	65
Stephenson Mfg. Co	83
Stewart Heater Co	98
Strong, Carlisle & Hammond Co	95
Struthers-Wells Co	108
Sturtevant Co., B. F	100
System Co	63
Toledo Pipe Threading Machine Co	89
Trill Indicator Co	100
Trimont Mfg. Co	65
Triumph Electric Co	107
Triumph Ice Machine Co	108
Underwood & Co., H. B	109
U. S. Mineral Wool Co	77
Vanda Co	76
Vilter Mfg. Co	109
Vogt Machine Co., Henry	104
Walch & Wyeth	67
Walton Co., F. S	84
Warren Steam Pump Co	103
Watertown Engine Co	109
Watson & McDaniel Co	95
Watson-Stillman Co	81
Webster & Co., Warren	57
Westinghouse Electric & Mfg. Co	107
Wetherill & Co., Robert	111
Wheeler Condenser & Eng. Co	102
Whitlock Coil Pipe Co	99
Wickes Boiler Co	103
Wiederholdt Construction Co	92
Wilkinson Mfg. Co	91
Williams & Co., J. H	63
Williams Foundry and Machine Co	83
Williams Valve Co., D. T	84
Wing Mfg. Co., L. J	92
Worthington, Henry R	102
Yale & Towne Mfg. Co	81
York Mfg. Co	111

Classified Index to Articles Advertised

Air Compressors

American Steam Pump Co., Battle Creek, Mich.
McGowan Co., John H., Cincinnati, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Westinghouse Traction Brake Co., Pittsburg, Pa.
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De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, O.
York Mfg. Co., York, Pa.

Arch, Back Combustion Chamber

McLeod & Henry Co., Troy, N. Y.
Mayville Specialty Mfg. Co., Mayville, Wis.

Arch, Boiler

McLeod & Henry Co., Troy, N. Y.

Arch, Boiler Door

Mayville Specialty Mfg. Co., Mayville, Wis
McLeod & Henry Co., Troy, N. Y.
Presbrey Fire Brick Co., Taunton, Mass.

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Carey Co., The Philip, Cincinnati, O
Johns-Manville Co., H. W., New York.
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Babbitt Metal

Allan & Son, A., New York.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

Bars, Boring Cylinder

Underwood & Co., H. B., Phila., Pa.

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Cling-Surface Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.
Johnson Co., Henry, Jersey City, N.J.
Rhoads & Son, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.
Stephenson Mfg. Co., Albany, N. Y.
Walton Co., F. S., Philadelphia, Pa.

Belt Fasteners

Bristol Company, The, Waterbury, Conn.

Belt Lacing

Bristol Co., The, Waterbury, Conn.

Belting

Anchor Packing Co., Philadelphia, Pa.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
N. Y. Belting & Packing Co., New York.
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Restein Co., Clement, Philadelphia, Pa.
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Bends, Wrought Iron Pipe

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Whitlock Coil Pipe Co., Hartford, Conn.

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Yale & Towne Mfg. Co., New York.

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Beggs & Co., James, New York
De Laval Steam Turbine Co., Trenton, N. J.
Green Fuel Economizer Co., Matteawan, N. Y.
McClave-Brooks Co., Scranton, Pa.
Ohio Blower Co., Cleveland, O.
Sirocco Engineering Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Blowers, Furnace

McClave-Brooks Co., Scranton, Pa.

Boiler Feeders

American Boiler Economy Co., Philadelphia, Pa.
American Steam Pump Co., Battle Creek, Mich.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Lunkenheimer Co., Cincinnati, O
Myers & Bro., F. E., Ashland, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Boiler Skimmers

Buckeye Boiler Skimmer Co., Toledo, Ohio.

Boilers, Second Hand

Wickes Boiler Co., Saginaw, Mich.

Boilers, Tubular

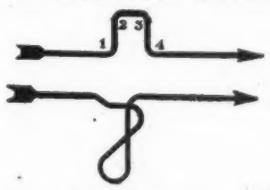
Babcock & Wilcox Co., New York.
Beggs & Co., James, New York.
Edge Moor Iron Co., Edge Moor, Del.
Franklin Boiler Works Co., Troy, N. Y.

COCHRANE SEPARATORS

ABOUT CENTRIFUGAL FORCE

Some separator manufacturers talk a great deal about centrifugal force, but the separators they build show that they have not fully comprehended the principles involved in the separation of suspended liquid particles from a current of steam.

The fundamental facts are, *first*, every particle in motion moves in a straight line unless influenced by external forces, and, *second*, a particle of water weighs more than 200 times as much as a particle of steam at, say, 100 lbs. pressure. This means that, if the direction of the steam current be changed abruptly, the flying water particles shoot on through the steam for a considerable distance, like the grains of sand in a sand blast.



In the Cochrane Separator, these particles shoot against a ribbed baffle, down which they can trickle into a well. The ribs on this baffle prevent the steam from scrubbing the oil or water off again. This baffle is placed squarely across the current of steam so that the particles of water strike perpendicularly, while the steam current must take a right angle turn.

In most so-called "centrifugal" separators, however, the steam goes around by easy curves and the particles of water are supposed to be thrown out against a smooth wall of the passage. The easy curves through which the steam turns give time for the water particles to be accelerated and carried along in the new direction. Moreover, in these so-called "centrifugal" arrangements, the parts are not so disposed that the particles of water thrown out of the current of steam are kept out of it permanently.

The ultimate test, however, is results, and we will guarantee Cochrane Separators to take the oil out of exhaust steam so thoroughly that the water condensed from that steam will be entirely suitable for boiler feed (Cochrane Separators now protect over 8,000,000 H.P. of boilers from oil) and likewise that they will deliver dry steam without regard to the quantity of water in the steam entering them and with the capacity dependent upon the removal from the separator well of the water which the separator takes out of the steam.

If you are thinking of putting in a Separator, buy a Cochrane. Our catalogue No. 15–S illustrates the different lines and types, some one of which will exactly answer your conditions and requirements.

HARRISON SAFETY BOILER WORKS,
17TH. & CLEARFIELD STS., PHILADELPHIA, PA.

TALK 6

Boilers, Tubular—*Continued.*

Griffith & Wedge Co., Zanesville, O.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler & Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Oil Well Supply Co., Oswego, N. Y.
Robb-Mumford Boiler Co., Amherst, N. S.
Struthers-Wells Co., Warren, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Wetherill & Co., Robert, Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

Boilers, Water Tube

Babcock & Wilcox Co., New York.
Edge Moor Iron Co., Edge Moor, Del.
Franklin Boiler Works, Troy, N. Y.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Morrin Climax Boiler Co., Brooklyn, N. Y.
Oil Well Supply Co., Oswego, N. Y.
Parker Boiler Co., Philadelphia, Pa.
Rust Boiler Co., Pittsburg, Pa.
Struthers-Wells Co., Warren, Pa.
Vogt Machinery Co., Henry, Louisville, Ky.
Wetherill & Co., Robt., Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

Books

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Text Book Co., Scranton, Pa.
System Co., Chicago, Ill.

Boosters

Ridgway Dynamo & Engine Co., Ridgway, Pa.

Building Materials, Fireproof

Carey Co., The, Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.

Castings, Brass and Iron

Homestead Valve Mfg. Co., Pittsburg, Pa.
McClave-Brooks Co., Scranton, Pa.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Castings, General

Neemes Bros., Troy, N. Y.

Castings, Malleable

Jeffrey Mfg. Co., Columbus, O.

Cement, Asbestos

Johns-Manville Co., H. W., New York.
N. Y. Belting & Packing Co., New York.

Cement, Boiler

Smooth-On Mfg. Co., Jersey City, N. J.

Chimneys

Wiederholdt Construction Co., Chicago, Ill.

Chimneys, Reinforced Concrete

Wiederholdt Construction Co., Chicago, Ill.

Clamps, Steam Joint

McCrea & Co., James, Chicago, Ill.

Cleaners, Boiler Tube

Buckeye Boiler Skimmer Co., Toledo, Ohio.
Garlock Packing Co., Palmyra, N. Y.
General Specialty Co., Buffalo, N. Y.
Liberty Mfg. Co., Pittsburg, Pa.
Monarch Steam Blower Co., Troy, N. Y.
Pierce Co., Wm. B., Buffalo, N. Y.
Stewart Heater Co., Buffalo, N. Y.

Clocks, Engine Room

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Clutches, Friction

Williams Fdry. & Mach. Co., Akron, Ohio.

Cocks, Blow-Off

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Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Cocks, Gage

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Huyette Co., P. B., Philadelphia, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Reliance Gauge Column Co., Cleveland, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

Cocks, Steam

Homestead Valve Mfg. Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, O.

Compound, Boiler

Binghamton Boiler Compound Co., Binghamton, N. Y.
Bird-Archer Co., New York.
Buckeye Boiler Skimmer Co., Toledo, Ohio.
Dearborn Drug & Chemical Co., Chicago, Ill.
Hawk-Eye Compound Co., Chicago, Ill.
Johns-Manville Co., H. W., New York.

Compound, Lubricating

Cook's Sons, Adam, New York.

Condensers

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American Steam Pump Co., Battle Creek, Mich.
Baragwanath & Son, Wm., Chicago, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Schutte & Koerting Co., Philadelphia, Pa.
Stewart Heater Co., Buffalo, N. Y.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., New York.

Consumers, Smoke

Climax Smoke Preventer Co., Boston, Mass.

Controllers, Electric

General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa

Controllers, Feed Water

American Boiler Economy Co., Philadelphia, Pa.

Cooling Towers

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Baragwanath & Sons, Wm., Chicago, Ill.
Wheeler Condenser and Engineering Co., New York.

Correspondence Schools

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International Correspondence Schools, Scranton, Pa,

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Covering, Pipe and Boiler

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Johns-Manville Co., H. W., New York.
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Curtis & Curtis Co., Bridgeport Conn.
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Oster Mfg. Co., Cleveland, O.

District Steam Heating

American District Steam Co., Lockport, N. Y.

Draft Apparatus, Mechanical

Green Fuel Economizer Co., Matteawan, N. Y.
Wing Mfg. Co., L. J., New York.

Drills, Upright

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Crocker-Wheeler Co., Ampere, N. J.
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General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
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General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
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Triumph Electric Co., Cincinnati, O.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

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Educational

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Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
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Northern Electrical Mfg. Co., Madison, Wis.

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Riverside Engine Co., Oil City, Pa.
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Erie Mfg. & Supply Co., Erie, Pa.
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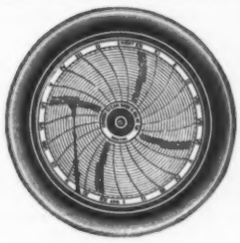

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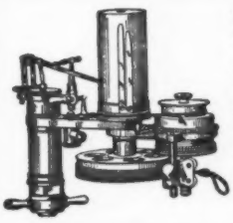

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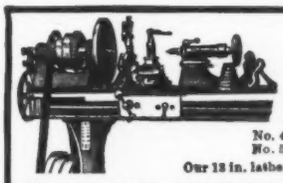

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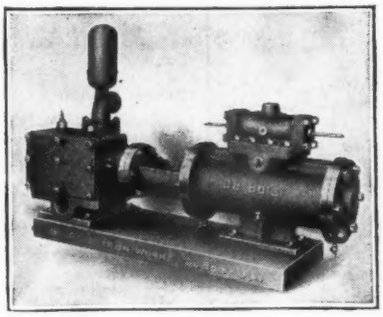

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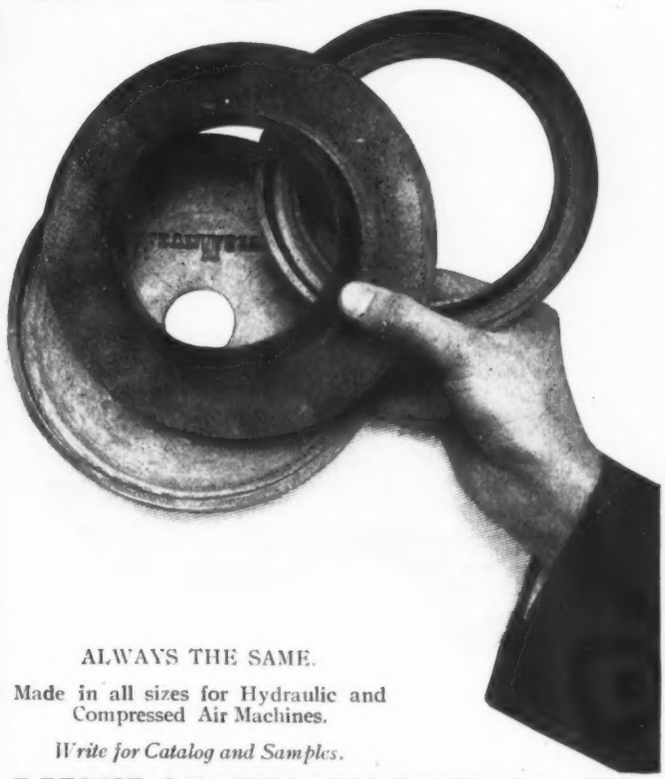

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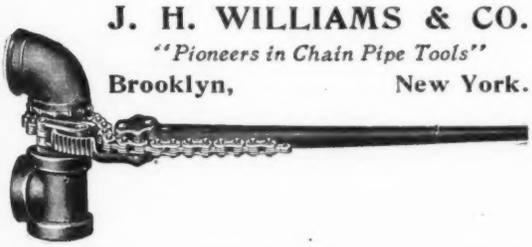

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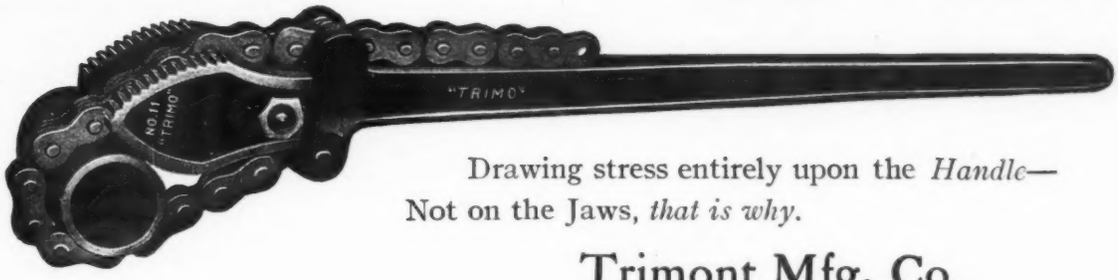

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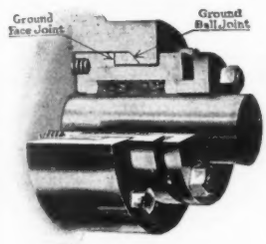

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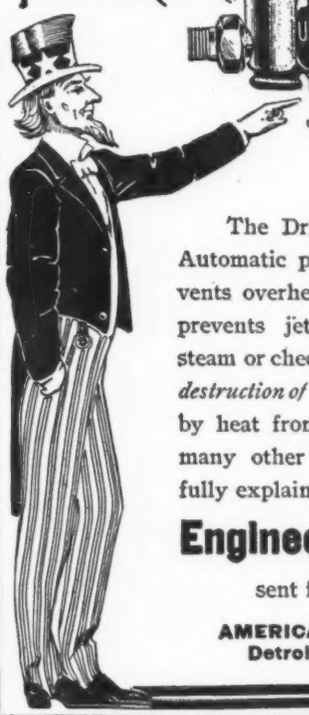

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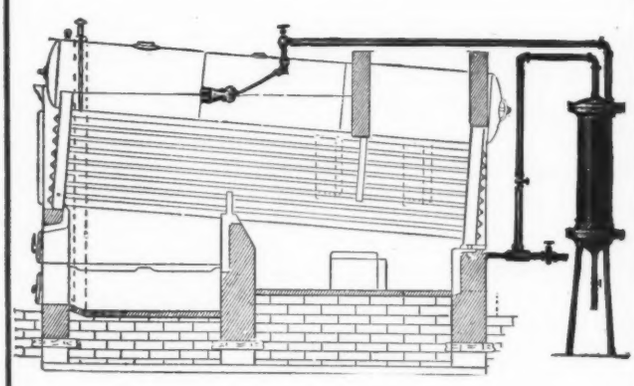

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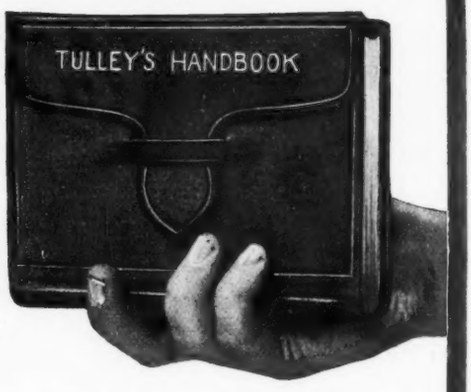

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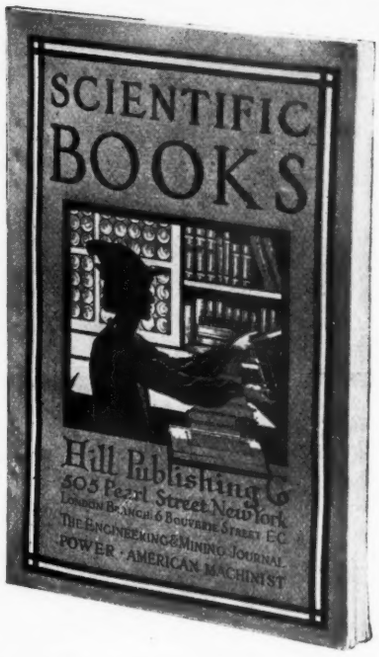

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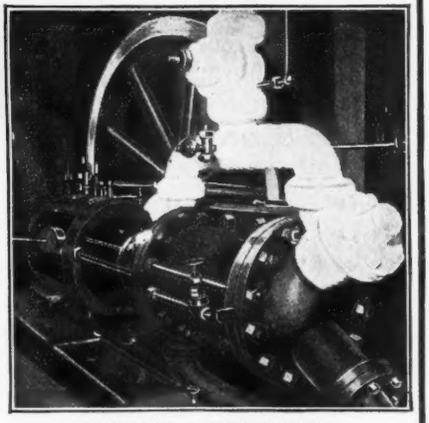

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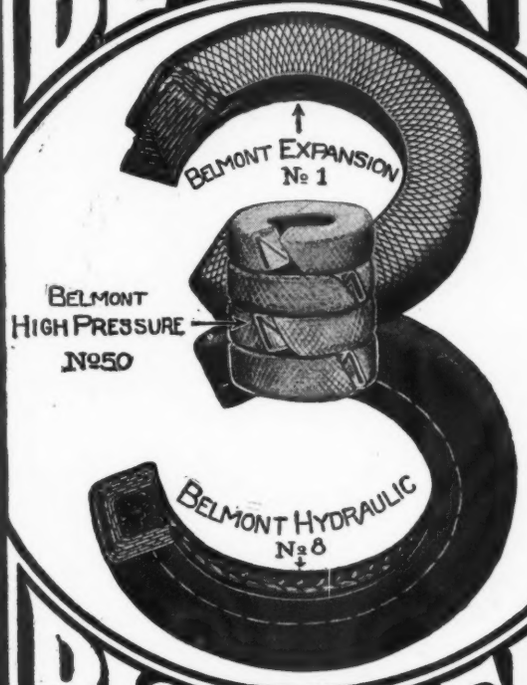

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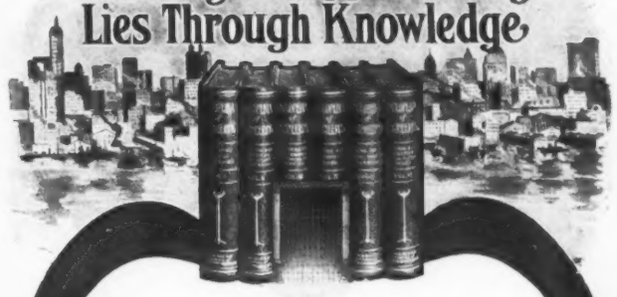

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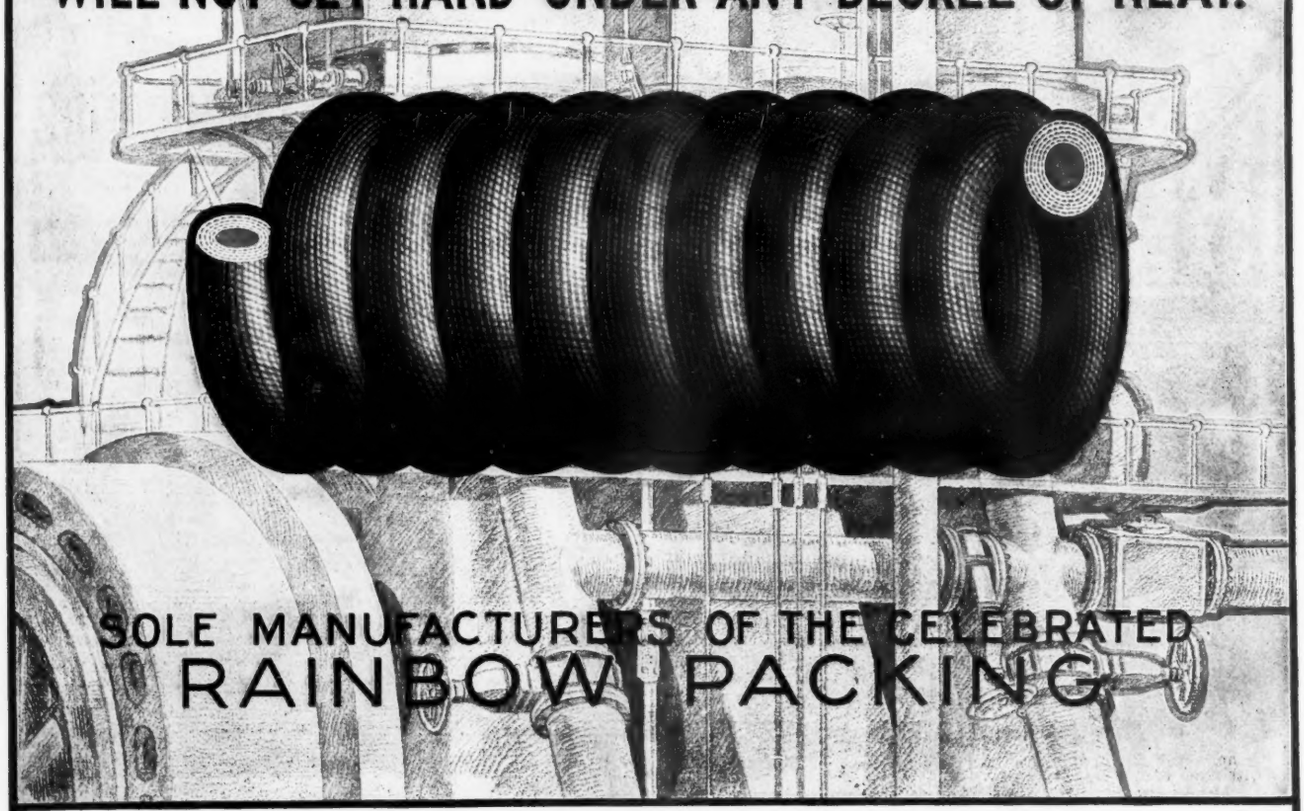

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N. I. R. Packings are best for all purposes. N. I. R. Red Sheet resists the highest steam pressure.

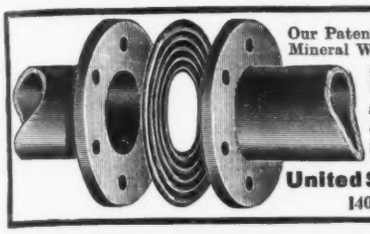
NATIONAL INDIA RUBBER CO.
FACTORY, BRISTOL, R. I.

BRANCHES: 42 Broadway, New York. 84 Lake St., Chicago. 140 Essex St., Boston. 37 Hopkins Pl., Baltimore. 279 Washington St., Buffalo.

The Johnson Packings

are more often reordered than any other packings on the market. There can be but one reason for this. Write.

THE HENRY JOHNSON COMPANY,
175-187 GATES AVENUE, JERSEY CITY, N. J.



Our Patented Mineral Wool **Pipe Covering and Copper Gaskets** Save Steam and Make Absolutely Tight Joints. Best and Cheapest. Samples Free.

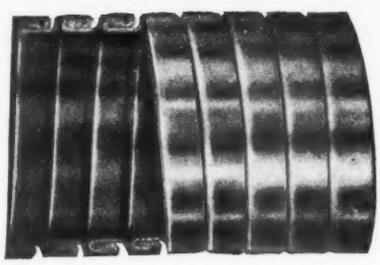
United States Mineral Wool Co.,
140 Cedar Street, New York

Bearing on the Rod

with only half the rings—Law Improved Metallic Packings.

Write for a Circular.

HOUCHIN-AIKEN COMPANY,
SOLE MANUFACTURERS,
113-121 53d St., Brooklyn, N. Y.



Made with an Interlocking Joint

The Pennsylvania Metallic Tubing is as flexible as rubber hose in the smaller sizes and much more so in the larger. Constructed of copper or steel tape rolled into spiral form and interlocking around an asbestos packing.

Circular?

PENNSYLVANIA FLEXIBLE METALLIC TUBING CO.,

H. A. ANSELL **1305 ARCH STREET, PHILADELPHIA, PA.** S. H. COLLOM

NEW YORK: 86 Warren Street. BOSTON: 71 High Street. DETROIT: 601 Stevens Bldg. CHICAGO: 255 LaSalle Street.

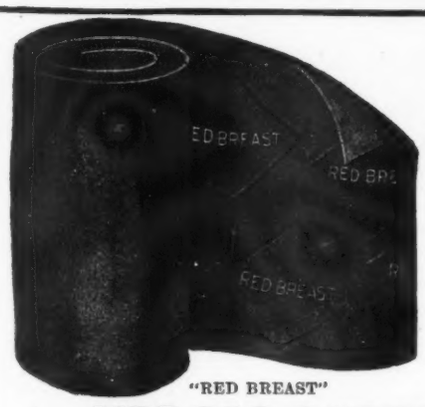
We Want To End Your Troubles

and make leaky joints only a memory in your plant.

Goetze's Elastic Copper Gaskets

are giving perfect satisfaction in millions of joints where leaks had been persistent till Goetze's Gaskets were employed. *Write for free samples.*

AMERICAN GOETZE-GASKET AND PACKING COMPANY,
525 EAST 149TH STREET, NEW YORK.



"RED BREAST"

Red Breast Packing

A Standard Red Sheet Packing—Will not crack or harden under any degree of heat; absolutely impervious to the influence of alkalies, oils and Ammonia; positively won't contract or expand; and will withstand the highest pressure.

Write for Free Sample

This Packing is better than others—far better—and, better still, is low priced. We will gladly send samples **Free** upon request.

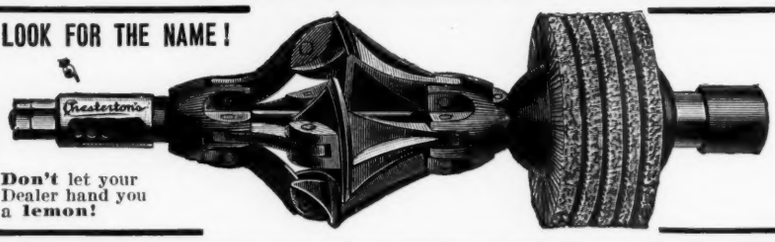
MERCER RUBBER CO., Hamilton Square, New Jersey
Branch Offices—Philadelphia, 421 Arcade Bldg. New York, 250 Fulton St. Pittsburg, 8th and Liberty Sts. Denver 610 Exchange Bldg., and Chicago, 40 Dearborn St.

Tough, Pliable, Elastic Selden's Patent and Zena Packing.

RANDOLPH BRANDT,
72 Cortlandt Street, New York.

ZENA

LOOK FOR THE NAME!



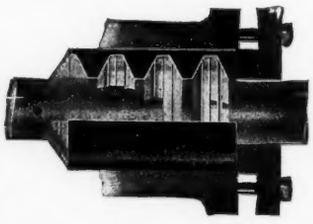
Don't let your Dealer hand you a **lemon!**

Cleans GOING and COMING!
THE "COMBINATION"
(Trade Mark Reg.)
Leaves the tubes as **clean** as **new.**
Durable and **self-adjusting.**

A. W. CHESTERTON CO., 64 INDIA STREET, BOSTON, MASS.
Or Advance Packing & Supply Co., 123 Franklin St., Chicago.

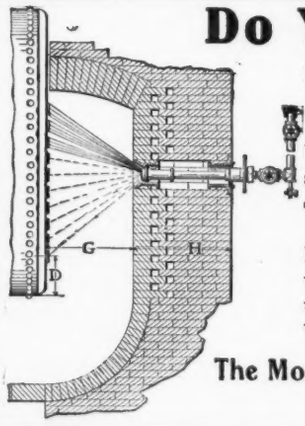
SOLD ON TRIAL

and if
Sterling Metallic Packing
fails to satisfy you in every particular it will not cost you anything. *Catalog?*



Monarch Steam Blower Co.
TROY, N. Y.

Do You Know



how much coal is wasted in your plant every day owing to soot accumulation in the boiler flues? It runs up into a large amount in the course of a year.

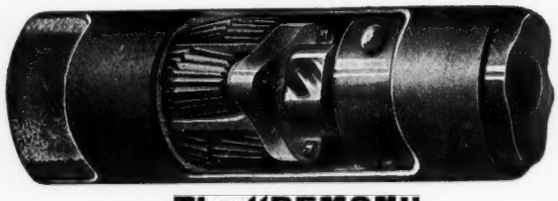
A Monarch Steam Flue Blower would stop this waste. It blows the soot in the direction of natural draft. Why not order one on trial?

The Monarch Steam Blower Co.
Troy, New York

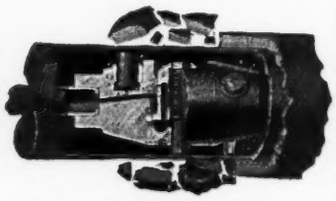
CHALLENGE!

DO YOU ACCEPT?

Cutters Are Set Non Yieldingly To Full Size Of Clean Tube



The "DEMON"



The "TORPEDO"

THE "TORPEDO"
Removes all scale from tubes of fire tube boilers.
Saves 11 per cent of fuel for each 1-16 inch of scale.
Prolongs life of tubes.
Saves compound.
Centers itself in tube.
Strikes same in every direction.
Stroke limited and cushioned.
Does not hammer but vibrates the tube.
Is absolutely safe and easily operated.
Has but one moving part.
Will last a lifetime.

Would you accept a wager that one of our cleaners could not remove at least one hundred (100) lbs. of scale from one of your boilers?

No matter what your boiler inspector reports or what cleaner or compound you use, we challenge you to this test:

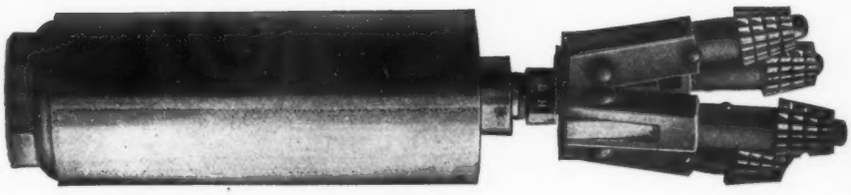
We will send on 30 days' free trial any size "DEMON" or "TORPEDO". Clean out a boiler with it that has just been cleaned by your method. If our cleaner does not remove at least 100 lbs. scale from one Boiler, express the cleaner back to us at our risk and expense.

Remember these cleaners are guaranteed to save from 3% to 20% in fuel in ANY plant. If they do what we claim you can not afford to be without them. Will you accept the challenge and free trial offer?

Don't fail to read our folder No. 54 "DEMON CLEANERS VS. OTHER CLEANERS" or circular No. 30 "How To Tell A Good Fire Tube Cleaner." Folder No. 56 describes the "DEMON" Curved Tube cleaner.

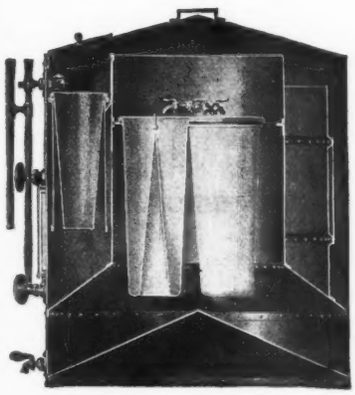
The General Specialty Co., 887 Niagara Street, Buffalo, New York.

LIBERTY DEVICES



The remarkable thing about Liberty Devices is that they do *more* than you expect them to do.

Take the **Liberty Turbine Cleaner.** You *expect it* to remove the scale, else you wouldn't buy it, but you'd hardly expect it to clean two tubes while any other cleaner is cleaning one. It *does* though.

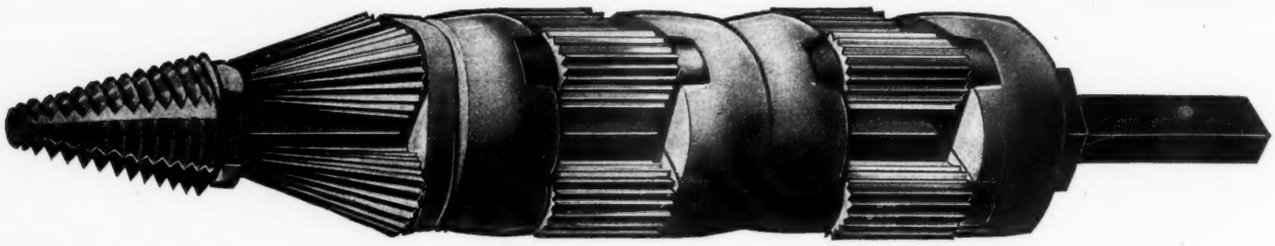


It's the same with the **Liberty Oil Purifier.** You naturally *expect it* to save oil, but do you know that it *refines* the oil, instead of simply straining it as other oil cleansing devices do? And the **Liberty Twin Strainer**. It does what you *expect;* strains the water, but one side works while the other side is being cleaned.

GET THE CATALOG

LIBERTY MANUFACTURING CO.

6509 Susquehanna St., PITTSBURG, PA.



A WORD ABOUT ECONOMY IN BOILER CLEANING

It isn't always FIRST COST that tells. The Weinland Mechanical Cleaner costs more than a Turbine but outlasts TWENTY TURBINES. The MECHANICAL is then "still in the ring" and with a few working parts replaced, is good as twenty more turbines. Besides the Mechanical Cleaner goes right through scale that a turbine could not remove. That the

WEINLAND MECHANICAL CLEANER

effects ACTUAL SAVING in big plants has been demonstrated at the plant of the Syracuse Rapid Transit Co., Syracuse, N. Y.

Very hard scale $\frac{3}{8}$ to 1 inch thick had formed in their B. & W. and Root Boilers. Under the most favorable conditions, it was possible to clean only from two to five tubes a day with any turbine that could be found. A WEINLAND MECHANICAL CLEANER put from 20 to 40 tubes into first class shape every day until the work was done.

As to repairs. This Cleaner kept 888 4-inch tubes (20 ft. long) in good condition for a whole year at the trifling cost of $15.00 for cutters.

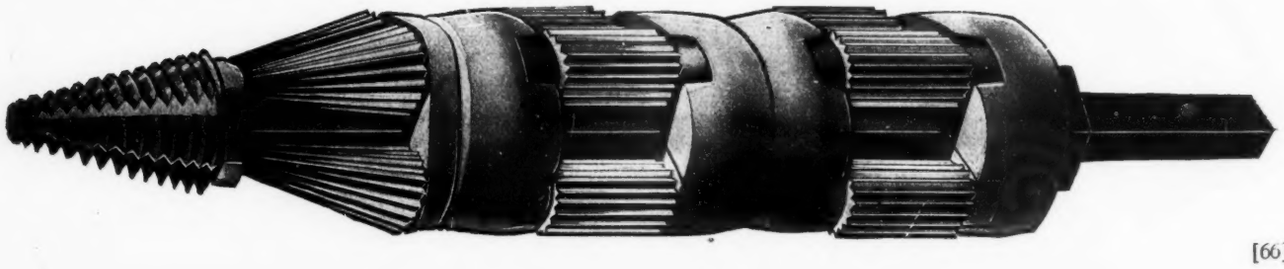
Could a Turbine have done this? Not much!! This is no "knock" at Turbines. We make "the best turbines on earth" but we want you to KNOW THE FACTS.

Tell us your troubles and we'll give you disinterested advice and furnish the cleaner best suited to your conditions. If you don't have much cleaning to do or the scale doesn't get very thick, our new Weinland Wing Arm Turbine Cleaner used regularly, will keep your boilers in first-class condition.

THE LAGONDA MFG. CO., Springfield, Ohio.

Makers of Lagonda Automatic Cut-Off Valves, Reseating Machines and Tube Cutters.

New York Philadelphia Pittsburg Chicago San Francisco Birmingham Toledo London



How do you do your Hoisting

In Yale & Towne Chain Blocks

are embodied the final development in lifting mechanism and the highest integrity in Chain Block construction. They lead in efficiency, speed, durability, reliability and universal adaptation to every hoisting requirement.

Triplex Blocks—½ to 40 tons. Universally recognized as the most durable and efficient Chain Block made. Have balanced train of spur Gearing with large internal gear.

Duplex Blocks—½ to 10 tons. The handiest and safest Screw Blocks made. Have safety guides to prevent slipping of load chains. Bronze Worm wheels and steel worms with hardened and ground thrust bearings running in oil.

Differential Blocks—⅛ to 3 tons. Not as durable or easy lifting as the Triplex or Duplex, but safe and twice as durable as the cheaper kind of the Weston Differential Block, because of superior Chain and Sheaves.

Y. & T. Blocks, duplicate parts and trolleys are carried in stock by Hardware, Machinery and Mill Supply Dealers. Write for catalog.

The Yale & Towne Mfg. Co.,
9 Murray Street, New York.

HYDRAULIC JACKS

Every type of first class thoroughly guaranteed Hydraulic Jacks for all classes of work are manufactured by us.

Over 400 different types and sizes from 2 to 1000 tons capacity.

Each and every tool guaranteed.

Send for Jack Catalog No. 68.

Watson Stillman Co.,

50 Church St. New York City.

Chicago Office, 453 Rookery.

We're Going to Raise Your Salary

"Yes, young man, we find that the training you have applied to your work has been so beneficial to the Company that we are going to encourage your further efforts by raising your salary."

Such scenes as these are actually taking place every day. The man who gets the raise is the **trained** man—the expert—while the untrained man plods along at the same old wages. If **you** are poorly paid and have ambition, there is a practical and definite system by which you can obtain promotion—a system that last year brought over $20,000,000 in increased salaries to the men that adopted it.

You won't have to leave home; there'll be no interruption in your work; there's no age limit; you won't have to buy books; it makes no difference what you do or where you live; lack of capital is no barrier; it makes no difference how scant your spare time may be.

If you are ambitious, mark and mail this coupon **NOW** and find out the most practical way to raise your salary.

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 979, Scranton, Pa.

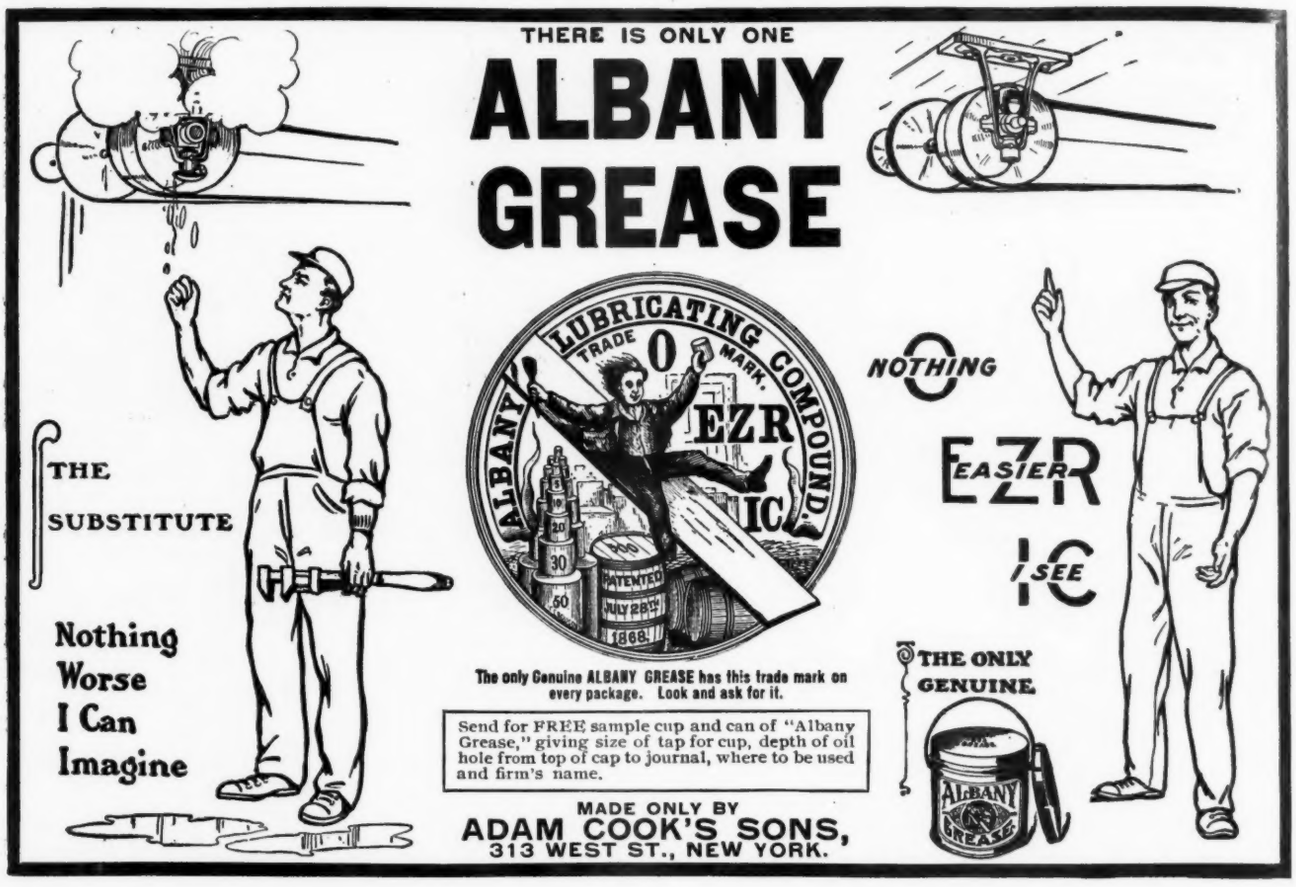
Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked **X**.

Electrical Engineer	Machine Designer	Sanitary Engineer
Elec.-Lighting Supt.	Mechanical Draft.	Architect
Elec.-Railway Supt.	Foreman Machinist	Architectural Draft.
Electrician	Foreman Toolmaker	Ad Writer
Telephone Engineer	Foreman Molder	Window Dresser
Civil Engineer	Foreman Blacksmith	Chemist
Bridge Engineer	Marine Engineer	Sheet-Metal Draft.
Mechanical Engineer	Hydraulic Engineer	Ornamental Design.
Stationary Engineer	Municipal Engineer	Textile Designer
Gas Engineer	R. R. Construc. Eng.	Bookkeeping
Refrigeration Eng.	Surveyor	Stenographer
Traction Engineer	Mining Engineer	Civil Service Exams.

Name _____

St. and No. _____

City _____ *State* _____


THERE IS ONLY ONE
ALBANY GREASE
THE SUBSTITUTE
Nothing Worse I Can Imagine
LUBRICATING COMPOUND
TRADE MARK
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PATENTED JULY 28TH 1868
NOTHING
EASIER
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THE ONLY GENUINE
ALBANY GREASE
The only Genuine ALBANY GREASE has this trade mark on every package. Look and ask for it.
Send for FREE sample cup and can of "Albany Grease," giving size of tap for cup, depth of oil hole from top of cap to journal, where to be used and firm's name.
MADE ONLY BY
ADAM COOK'S SONS,
313 WEST ST., NEW YORK.

Fill Up The Surface Inequalities With

Dixon's Flake Graphite

and the bearings will not need much oil.
Ask for free sample can 94-C.

JOSEPH DIXON CRUCIBLE COMPANY,
JERSEY CITY, - - - - NEW JERSEY.

LATEST **IMPROVED**

ROCHESTER

AUTOMATIC **LUBRICATORS**

give perfect force feed lubrication and *save oil, time, money* and *labor.*
Try one, or at least, send for a catalog.

GREENE, TWEED & CO., SOLE MANUFACTURERS, 109 Duane St., NEW YORK.

OIL-STEAMPROOF "Aqua" WATERPROOF

SHULTZ "AQUA" WATER-PROOF BELTING IS WATER-PROOF!

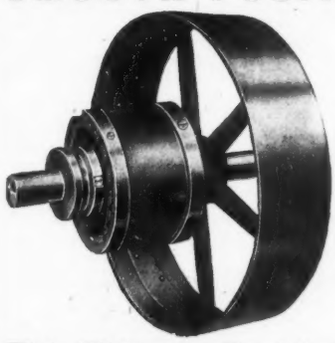
"AQUA" will transmit more power, and outwear many times any rubber, canvas or so-called "water-proof" oak-tanned belting.

Write for our BELT BOOK and Samples

THE SHULTZ BELTING CO., St. Louis, Mo.

NEW YORK BOSTON PHILADELPHIA

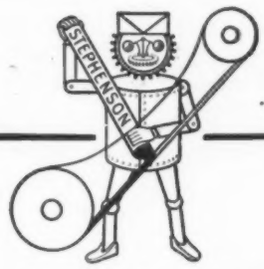
SMOOTH POSITIVE ACTION



The Akron Clutch will start the load gradually without shock or jar. If load exceeds horsepower of clutch, it will *slip*. Full protection against dust and grit, working parts entirely covered. Operating parts run in oil. Write today for circular.

The Williams Foundry & Machine Co., Akron, Ohio.

Successors to the Akron Clutch Co.



THE AFTER EFFECTS ARE PLEASANT

Don't waste good belts and lose valuable power. STEPHENSON Bar Belt Dressings contain no Rosin nor any other ingredients injurious to Belting. Our RED Label and GREEN Label Brands are two entirely different and distinct preparations. No one kind of Dressing is good for all Belts—you know that. STEPHENSON Dressing not only prevents slipping and gives full speed from slack belts, but the after effects are pleasant—it KEEPS those belts in good condition and greatly prolongs their life.

This means a saving in BELTING, which is an important item when figuring the year's expenses.

RED Label Brand for Leather belts;

GREEN Label for Rubber and Canvas.

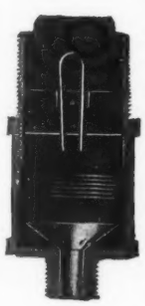
Your protection against substitution is The Man with the Cog-Wheel Face on each Pound Stick.

Of Dealers everywhere, or

STEPHENSON MFG. CO.

ALBANY, N. Y.

The "Philadelphia" Grease Cup



Automatic application of grease to the bearing without the use of spring compression. : : : :

Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : : :

With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

Write for catalogue and full information

The Philadelphia Lubricator & Manufacturing Co.

The Bourse (Exhibition Dept.), Philadelphia, Pa.

Detroit Improved Standard Lubricator

Some One

of our 337 different styles and sizes of sight-feed lubricators will fill any requirement you may have.

When ordering, insist on getting the genuine Detroit.

Write for a catalog of the most complete line of oiling devices for all purposes.

DETROIT LUBRICATOR COMPANY.

Detroit, U. S. A.

Which Valve is the Best?

WHEN ordering new valves, this question naturally comes to mind before any other. The next question that suggests itself is "Which valve costs the least to maintain?" To both of these questions there can be but one answer—*Williams Valves* are *best* because they stand higher pressures and last longer than others. *Cost of maintenance* amounts to nothing as they do not require extra discs or seats. If worn, they are easily and quickly reground with a little oil and emery. When finished, the valve is as good as new at no extra cost.

Williams Swing Check Valves

are excellent valves for use on boiler feed lines or any other place where the pressure must be controlled by a check valve. Heavy in construction, they have full and unobstructed passage through body which greatly reduces friction and necessarily prolongs the life of the valve. If you want higher valve efficiency at less cost—order Williams. They are strictly guaranteed for 200 pounds pressure.

Send us a postal for the new Williams catalog.

THE D. T. WILLIAMS VALVE CO.
904-910 Broadway, - CINCINNATI, OHIO
4

Robins Laminated Leather Belting

Is made continuous without laps, plies or cement. Guarantees an equal distribution of strength and an uninterrupted line of power transmission.

Write for circular No. 2.

ROBINS NEW CONVEYOR COMPANY

New York, 38 Wall Street | Factory, 168 Duane Street | Chicago, Old Colony Bldg.

The Homestead Straightway

This Valve is so constructed that when it is closed a traveling cam forces the plug firmly to its seat.

CATALOG?

HOMESTEAD VALVE MFG. COMPANY,
Brass Founders. **PITTSBURG, PA.**

SAGINAW MANUFACTURING CO.,
SAGINAW, MICH., U. S. A.
MANUFACTURERS OF
GILBERT WOOD SPLIT PULLEYS.
New York Branch, 88 Warren Street.
Chicago Branch, 32 South Canal Street.
Sales Agencies in all principal cities.
Cable Address, "Engrave" A. B. C. and Lieber's Code.

RHOADS LEATHER BELTING

Not merely weight but work tells the tale.

J. E. Rhoads & Sons
PHILADELPHIA 12 N. THIRD ST. BOSTON NEW YORK 40 FULTON ST.
HAMBLET & HAYES CO. EASTERN AGENTS, 105-111 SUMMER ST.
FACTORY WILMINGTON, DEL.

OXOILOX

VIENNOT-PHILA

A GOOD START

is half the battle, and the very best start for *any new belt* is a thorough treatment with OXoilOX—*The Perfect Belt Dressing.* It restores to leather the strength and vitality lost in tanning. Makes belts tough, yet soft and pliable, so that they adhere closely to the pulleys, and slipping is made almost impossible.

OXoilOX is not a "*dope*," and it doesn't make belts sticky; just keeps them clean and healthy so that they can live out their full life and do a good day's work each day. You can have

A FREE SAMPLE

F. S. WALTON CO., Philadelphia, Pa.

Gentlemen: Kindly send us, free of charge, a sample can of OXOILOX the Perfect Belt Dressing.

Name.....

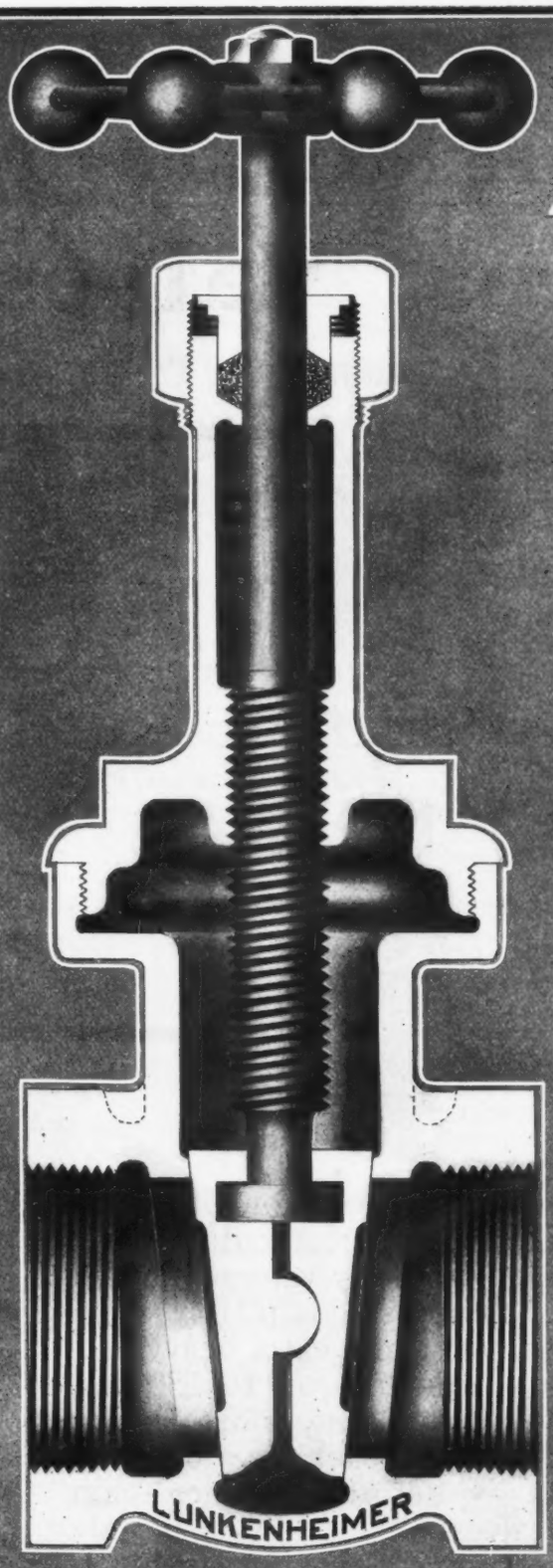
Address.....

Name of Firm.....

Number of Belts..... Average Size.....

F. S. WALTON CO., Philadelphia, Pa.

Pressers and Refiners of all grades of Neatsfoot oil



2 - DISCS 2 - SEATS

A double protection against leakage.

Lunkenheimer Double Disc Gate Valves

Have a ball and socket joint between the discs, which permits of independent adjustment. Dirt, scale, etc., lodging on the seat of one disc will not prevent the other from properly seating.

Made of the highest grade of bronze composition, in sizes from 1/4 to 3 inches inclusive. Unequalled for working pressures up to 150 pounds.

Have you a Lunkenheimer Catalog? They're free.

The Lunkenheimer Company

Largest Manufacturers of High Grade Engineering Specialties in the World

General Offices and Works, Cincinnati, Ohio, U.S.A.

Branches: New York, 66-68 Fulton St.; London, S.E., 35 Great Dover St.; Chicago, Lake and Dearborn Sts.

For Longest Wear In Hardest Service There Are No Equals To

Jenkins Bros. Valves.

IF you use globe, angle, check and Y or blow-off valves for any purpose you will get far greater durability, effectiveness and economy if you buy valves branded "Jenkins Bros." They are the most completely satisfactory valves made. The standard and extra heavy patterns are suitable for working pressures up to 150 and 300 pounds respectively. Only the best, most lasting steam metal is used and they can be repacked when wide open and under full pressure. ¶ Before you order again investigate "Jenkins Bros." valves.

SHALL WE SEND YOU THE CATALOG?

JENKINS BROS.

71 John Street, New York, N. Y.

133 No. 7th Street, Philadelphia.
35 High Street, Boston.
226-228 Lake Street, Chicago.
Queen Victoria St., London.

DAVIS PRESSURE REGULATORS SAVE STEAM

PRESSURE REGULATOR

Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

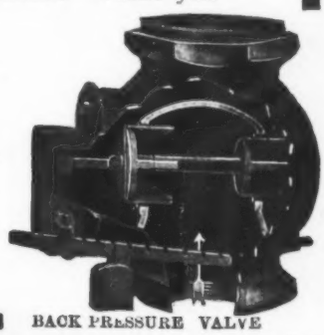
This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.

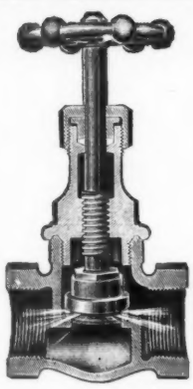


BACK PRESSURE VALVE

G. M. Davis Regulator Company,

142 Milwaukee Ave., CHICAGO.

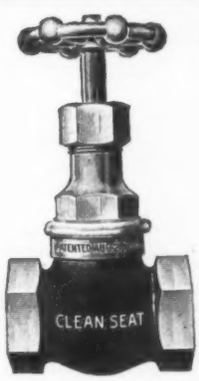
BRANCHES—NEW YORK—123 Liberty St. BOSTON—104 High St. ST. LOUIS, 735 S. 4th St.
SAN FRANCISCO—216 California St. PHILADELPHIA—56 N. 2nd St.
PITTSBURGH—1206 Park Building.



CLEAN-SEAT VALVES

ARE BEST WE SAY SO, AND CAN PROVE IT:

1. A VALVE tightly closed does not wear fast.
2. A VALVE cannot close tight on a dirty seat.
3. A VALVE should be able to keep its seat clean.
4. A VALVE which can do this will wear well.



THE CLEAN SEAT VALVE, every time it closes, throws a strong jet of steam directly across the seat, all the way round, as the disc approaches the seat. This jet blows away all sediment, scale, grit, rust, or other foreign matter, and insures tight closing *every time*, by clean metallic contact between disc and seat.

The "Clean-Seat" principle reduces the wear on seats and discs to a positive minimum and makes easy the ordinarily difficult work of controlling high pressures. For high pressure service this valve makes its most conspicuous showing, and it is made in the following heavy weights:

Medium for pressures up to and including 200 lbs.
Extra heavy for pressures up to and including 500 lbs.
Hydraulic for pressures up to and including 3,000 lbs.

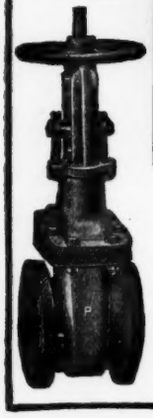
For long, hard and continuous service the "Clean-Seat" Valve has no rival. On this claim, we stand ready to submit conclusive proof, beyond even a reasonable doubt.

PRICES:

Size.....inches	⅛	¼	⅜	½	¾	1	1¼	1½	2	2½	3
Medium.....each	1.10	1.10	1.25	1.60	2.20	2.80	4.00	5.50	8.75	15.75	22.00
Extra Heavy. "	.....	3.00	3.50	4.00	5.00	6.50	8.25	11.00	16.00	33.00	45.00
Hydraulic... "	.....	5.00	5.00	6.00	7.50	10.00	12.50	16.50	24.00	50.00	65.00

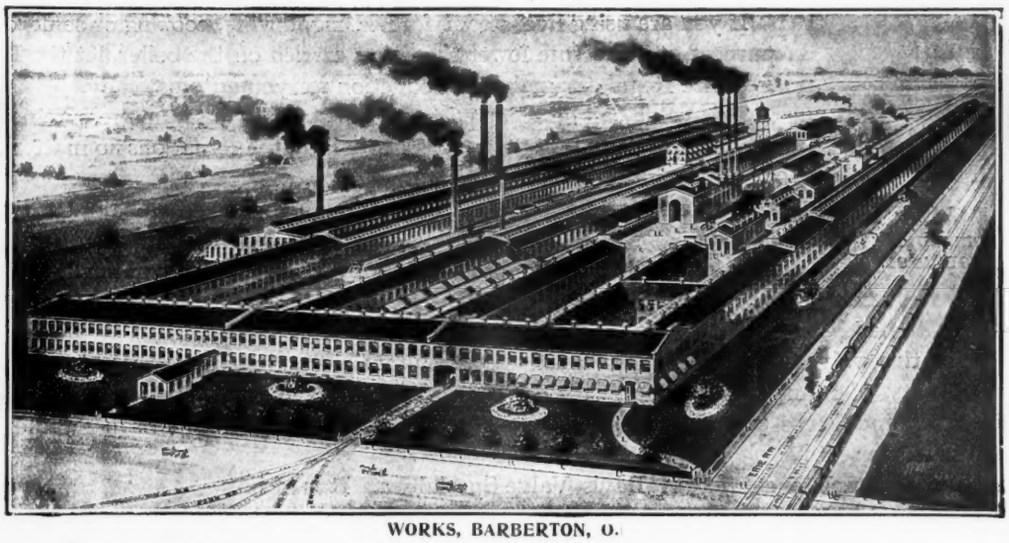
PITTSBURGH GAGE & SUPPLY CO., Pittsburg, Pa.

ALWAYS SPECIFY **P** VALVES AND FITTINGS.



PITTSBURGH IRON BODY GATE VALVES

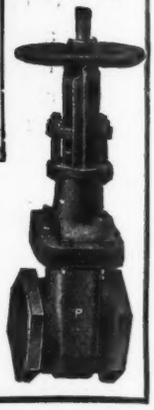
have been thoroughly tested under the most severe conditions known and have proved that they work under all pressures with less wear on the faces of the discs and seats than any other valves made.



WORKS, BARBERTON, O.

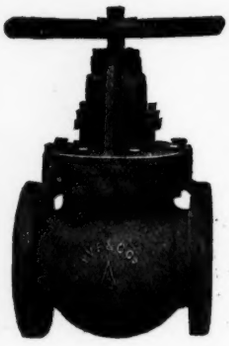
They are made standard for 150 lbs. and extra heavy for 250 lbs. working pressures. They can be furnished screwed, flanged or hub end; with by-pass, spur or bevel gearing and are suitable for steam, gas or water. They are made with outside screw and yoke or non-rising spindles. We have many thousands of them in use in all parts of the country and have never had a complaint or a valve returned.

ALWAYS SPECIFY **P** VALVES AND FITTINGS.



PITTSBURGH VALVE & FITTINGS COMPANY,

General Offices and Works: BARBERTON, O. We Manufacture all kinds of Valves and Fittings.



VALVES

Makes no difference what kind of a Valve you want, how you want it made or where you want it shipped, we can supply it on shortest possible notice.

We manufacture valves and pipage equipment of every description, for all kinds of plants, Steam Separators, Tuyere Cocks, Brass Unions, Etc. Also make Pipe Bends, and do all kinds of Pipe Fitting, either assembled or ERECTED.

SEND FOR CATALOG

PITTSBURGH VALVE FOUNDRY & CONSTRUCTION CO.

Pittsburgh Cleveland New York Boston Birmingham, Ala.

Stulp Automatic Safety Water Gauge

automatically grinds it own valve seats and cleans its way to the boiler. Approved by the U. S. Board of Supervising Inspectors of Steam Vessels.

Awarded Diploma and Medal at Jamestown Exposition.

The Automatic Safety Water Gauge Co.

Fred J. Stulp, Prop. MUSKEGON, MICH.

Mason Reducing Valves

keep the pressure at exactly the required point regardless of initial pressure changes and no one can alter their adjustment but the men who have the keys.

The Mason Regulator Co., Boston, Mass.

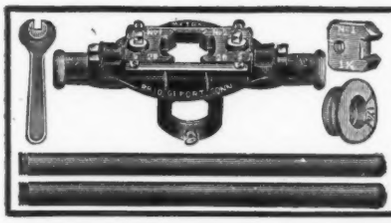
KNOWLEDGE IS SAFETY

When you've an accurate steam gauge you are safe on the one hand from accidents and on the other from fuel waste.

CATALOG "P?"

THE ASHTON VALVE COMPANY, Boston, U.S.A.

NEW YORK St. John's House, London, Eng. CHICAGO



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PIPE MACHINES,
PIPE CUTTERS,
VISES.

Manufactured by

The Armstrong Mfg. Co.

287 Knowlton St.,
BRIDGEPORT, CONN.

"Ohio" Steam Specialties

OHIO WATER GAUGE

THE "OHIO" WATER GAUGE IS DESIGNED FOR ENGINEERS WHO WANT THE

Best Gauge

It is finely finished, quick operating, has removable glass, made of high-grade steam bronze for 200 lbs. pressure.

We also make a line of high-grade bronze Collin Gauge Cocks. Heavy Bronze Fittings and Collin Steam Pressure Regulating Valves.

Catalogs P-F and P-B mailed on request.

The Ohio Brass Company

Mansfield, Ohio, U. S. A.

32 Cortlandt Street, New York 277 Dearborn Street, Chicago
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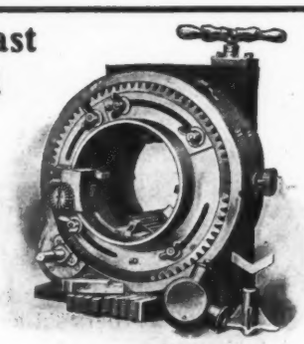
"Be Not the Last To Lay the Old Aside"

and install the new method of cutting and threading pipe. The Forbes Patent Die Stock is a proven time and money saver. The best plants in the country have adopted it. *Write.*



The Curtis & Curtis Co.

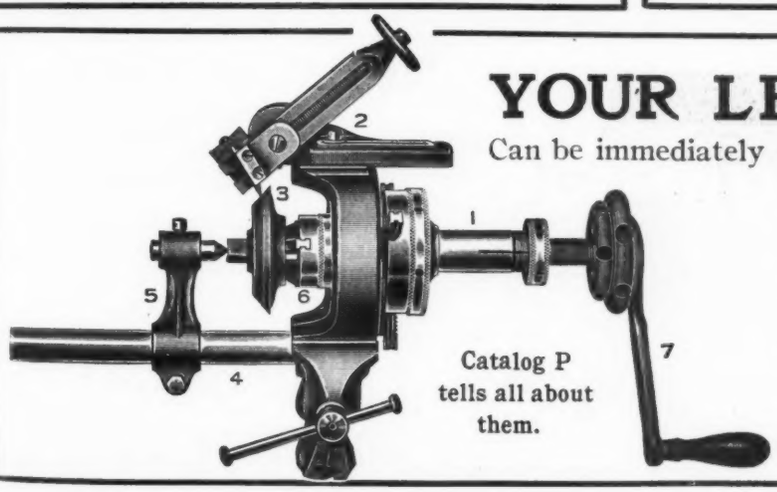
85 Garden St., Bridgeport, Conn.

EMERGENCY WORK IN POWER PLANTS MUST BE DONE IN A HURRY.

"TOLEDO" Pipe Threading Devices

thread pipe up to 12". ONE MAN can do it quickly and *in any place, in any position.* An invaluable line of tools. Let us tell you about them.

The Toledo Pipe Threading Machine Co.,
TOLEDO, OHIO.



Catalog P tells all about them.

YOUR LEAKY VALVES

Can be immediately reseated and made perfectly tight without removing the valve or disturbing the piping in any way, and they can be reseated again and again, at least ten times.

Can you afford to get along without a Dexter Valve Machine?

THE LEAVITT MACHINE CO.,
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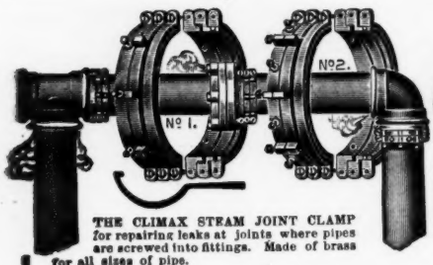

THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.

THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION

Send for Catalog of

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JAMES McCREA & CO.,

MANUFACTURERS,

61 West Washington Street, Chicago.

"M. & F."

Brass-To-Iron Contact

The "Kewanee" Union never rusts or corrodes and remains permanently tight. Fewer joints are needed. No gaskets required.

The "Kewanee" "M & F" Pattern has no equal for close work. Write for full particulars.

NATIONAL TUBE CO. Pittsburg, Pa.

DISTRICT SALES OFFICES

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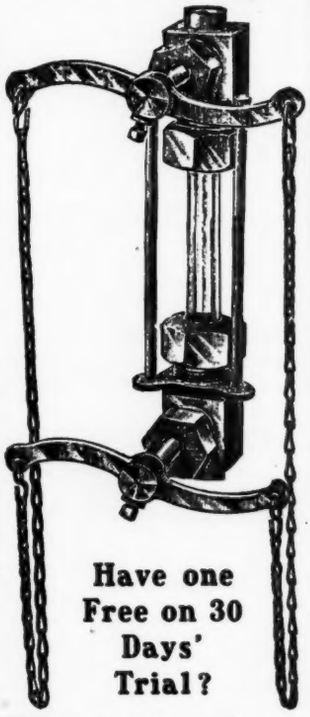
Shut Off The Gauge At A Safe Distance.

That's better than groping about in live steam and scalding water from a broken water gauge glass 'till your hands and face are parboiled.

The **"P. B. H." Quick Closing Water Gauge** enables you to shut off the steam and water by simply pulling a chain from a safe distance. It is substantially made from the best materials.

Say the word, and we'll sendyou one for a 30 days' free trial.

Circular anyway.



Have one Free on 30 Days' Trial?

The Paul B. Huyette Co.,

2025 Betz Building, Philadelphia, Pa.

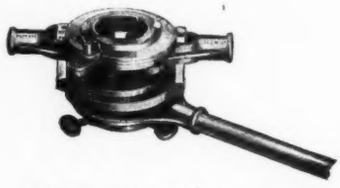
"BEAVERS" are the proper die stocks for use about factories

BECAUSE they are built on the easy working principle, enabling one man to thread any size pipe without calling for help.

Each Stock threads all sizes of pipe within its range without changing dies so you have no loose parts to carry around or get lost or misplaced.

And consider the time you save by not having to change dies.

They are a time proven success and of such practical advantage in saving time and labor as to compel their use from an economical standpoint once you realize it.

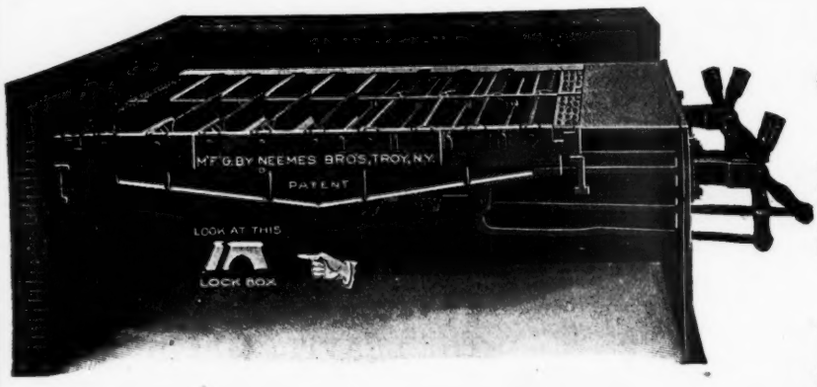


"Beaver" 1" to 2" Ratchet Stock.

Made in all sizes ¼" up.
Sold by all Jobbers subject to 10 days' trial.
We would like to send you descriptive matter.

THE BORDEN COMPANY

WARREN, O.



NEEMES BROS.

IMPROVED

Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

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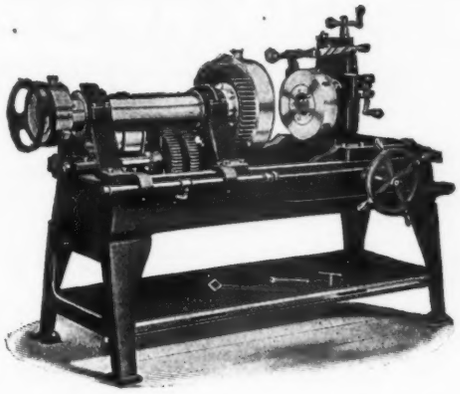
C. W. VAN BLARCOM, Room 533, Terminal Bldg., 30 Church St., Agent for New York City and vicinity BABCOCK & WILCOX, Ltd., Montreal, Canada, Sole makers for Canada BURKE ENGINEERING CO., 311 Industrial Bldg., Providence, R. I., Sole Agents for the New England States.



GOOD THREADS

may not be an absolute necessity if you use plenty of cement, yet there is no denying the fact that it is *better* to have *good* threads. Some may be satisfied with poor threads, but if you are a sticker for good ones, do your threading on a B. & K. PIPE MACHINE. *Yours for good threads.*

Bignall & Keeler Mfg. Co.
Edwardsville, Ill.

No Heat Units Wasted

The Wilkinson Automatic Stoker and Smoke Preventer burns any kind of coal completely leaving no values in the ash pit and permitting no fuel to escape as smoke. *Write for full particulars.*

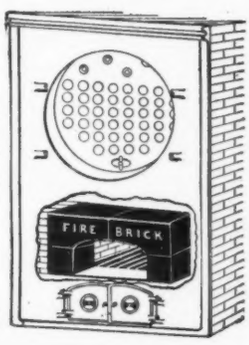
The Wilkinson Manufacturing Co.,
Bridgeport, Montgomery Co., Pa.

BOILER DOOR ARCH and JAMBS made of

NON-SHRINKING FIRE BRICK

The perfect mould, close fit and smooth, solid surface make them remarkably durable.

Write for booklet.



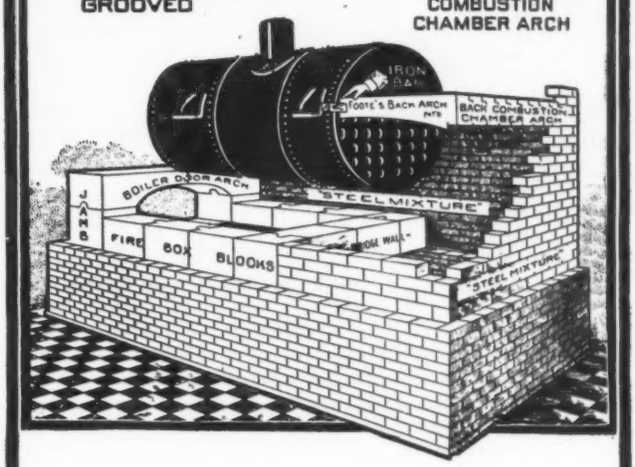
PRESBREY FIRE BRICK WORKS
D TAUNTON, MASS.

"STEEL MIXTURE"

BOILER DOOR ARCHES AND FIRE BOX BLOCKS

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH



Combustion Chamber Arches.

No boiler is well set unless it has a durable cover on the Combustion Chamber.

Foote's Patent Combustion Chamber Arch is the simplest and most efficient one known. Any one can install it. It's essential features are seen at a glance. Special blocks, shiplapped together, span the chamber supported by the back wall and an iron bar. The latter being in a socket in the blocks, is fully protected from the heat.

Between the boiler and the Arch is left a space packed with ground asbestos. This allows for expansion. The whole is then floated with fire clay cement.

Write for Dimension Booklet.

MANUFACTURED BY

McLEOD & HENRY CO.
TROY, N.Y., U.S.A.

BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

ANY TYPE OF BOILER

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

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UNITS OF ANY SIZE

"SIROCCO"

TRADE MARK

FANS AND BLOWERS

BUILT ON THE TURBINE PRINCIPLE

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MARTIN GRATES

Martin Anti-Friction Rocking Grates will burn slack coal and get the same steam results as ordinary grates do with best lump coal. Catalog tells why.

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Wing's Turbine Blower

FOR FORCED DRAFT

Most Efficient Most Compact Catalog?

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PREVENT SMOKE

Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.

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C-O-Two Furnace Tile

The best fire arch making material ever devised. Lasts longer. Increases combustion. Write for full description.

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CENTRAL STATION HEATING.

Write for valuable information.

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GREEN TRAVELING CHAIN GRATES

AUTOMATIC SELF CLEANING SMOKELESS

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COMMERCIAL NATIONAL BANK BLDG., CHICAGO.

GENERAL FOUNDY WORK A SPECIALTY

The Monarch Boiler Arch

hangs from above. It is a metallic backing faced with fire brick. Write for booklet.

MAYVILLE SPECIALTY MFG. COMPANY,

MAYVILLE, WIS.

A Money back Proposition

After a 30 days' trial—if you are not convinced that the Baum Separator will prove a profitable investment we will return your money and pay for returning the separator.

Send for new Catalogue and prices.

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MANHEIM, PA., U. S. A.

W. G. Ruggles Co., 54 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago. Ill.

We can elevate or convey your **COAL** a distance of 100 feet for less than **ONE CENT A TON**

in quantities of ONE TON A MINUTE or more.

Catalog Free.

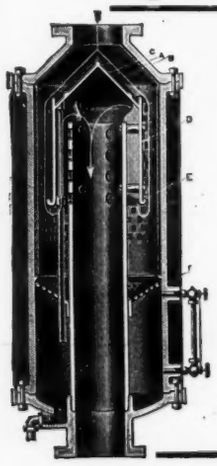
THE C. O. BARTLETT & SNOW COMPANY,

Cleveland Ohio.

"CHIMNEYS" built by our system never require paint or repairs of any kind. Write.

Wiederholdt Construction Company,

American Trust Bldg., Chicago, Ill.



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Steam Separators deliver 99.8 dry steam and oil separators remove 99% of oil from exhaust steam. They *do* it that's all. All styles.

DIRECT SEPARATOR COMPANY,

712 S. Geddes St., Syracuse, N. Y.

Over 7500 Hammel Oil Burners

In use under Stationary Boilers, Locomotives, Kilns, Etc.

Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

HAMMEL OIL BURNER CO.

609 North Main Street, LOS ANGELES, CAL.

Your Engine Will Run More Smoothly

give greater power, longer wear and require less steam if you protect it from condensation water with a Gardiner Separator.

WRITE!

The Gardner Governor & Separator Company,
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JEFFREY
Pivoted Bucket
CONVEYOR
HANDLING
Coal and Ashes in Power Plant

GRAB BUCKETS, STORAGE BINS, CRUSHERS, SCREENS, Etc.

The Jeffrey Mfg. Co.,
Columbus, Ohio, U. S. A.

New York Chicago Boston
Pittsburg Denver Charleston
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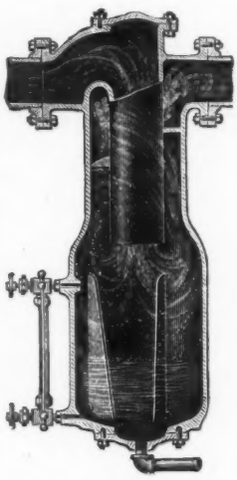
How Many Engines Have Been Wrecked

by an excess of water being carried into the cylinder? It would be interesting to know, because it is absolutely inexcusable when the use of a

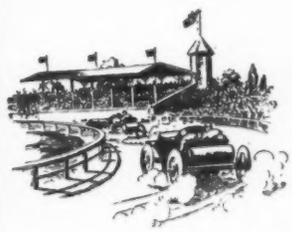


Stratton Separator Assures Absolutely Dry Steam

no matter how much the boilers may foam, or how long a pipe line is exposed to cause condensation. If the cut doesn't explain it our catalog will.

GOUBERT MANUFACTURING COMPANY
No. 90 West Street, New York City, N. Y.

WHEN THE AUTO

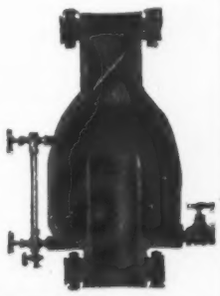


rounds the curve the tendency of everything to fly outward is restrained, but when a mass of steam revolves rapidly the action of centrifugal force upon the drops of oil and water is irresistable. In the "Swartwout" apparatus the flow is direct; there are no baffle plates; there is not an ounce loss of pressure. The Helico-Centrifugal Principle insures absolute separation.

The Ohio Blower Co.
Cleveland, Ohio.

Also manufacturers of the "Swartwout" Gravity-Closing Ventilators.

1-50



"Giving Entire Satisfaction"

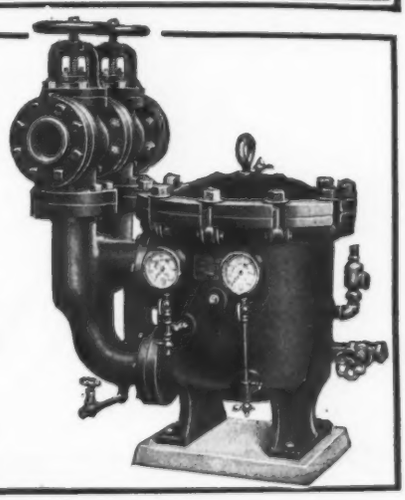
The above written by a leading lumber plant voices a common sentiment concerning the

Blackburn-Smith Feed Water Filter and Grease Extractor

This device offers the most logical method of removing mud and slime from the water supply and for extracting oil, greases and dirt from the condensation. Our system of double filtration through small terry covered cartridges makes good under the most severe conditions.

Write for booklet "Feed Water Filtration."

JAMES BEGGS & CO.
109 Liberty St., New York City



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Here's the story in a nutshell. Before *The Engineer* was combined with *Power* it was publishing the above books and advertising them. *Power* readers never got a chance at them, more's the pity because they are fine books, the kind that no engineer's library is complete without. Now we purpose to let *every* subscriber to *Power and The Engineer* get these books in combination at a price that is low in comparison to the regular charge and almighty low in comparison with their real value to every engineer. You'll recognize the truth of this, we believe, and send us your order, especially when you've read the guarantee below and know that you can examine the books without risking a cent.

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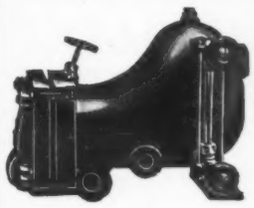

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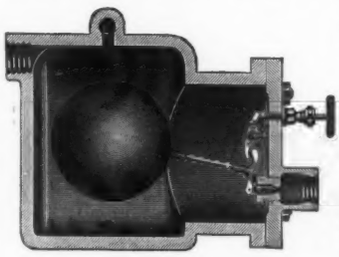

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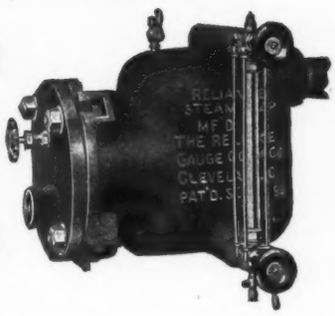

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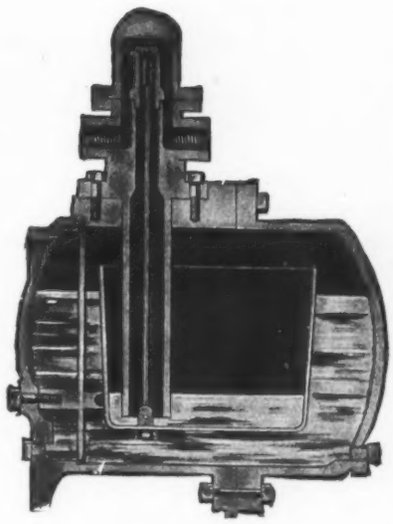

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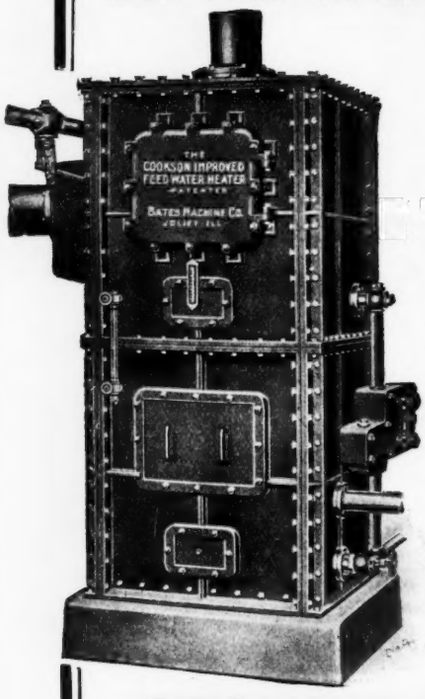

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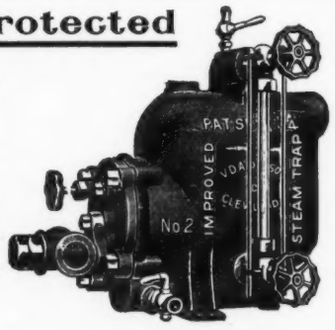

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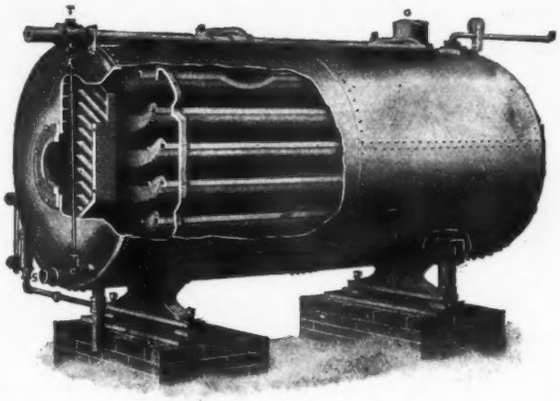

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Keep Boilers Clean Without Expense of Chemicals. Write for Particulars.

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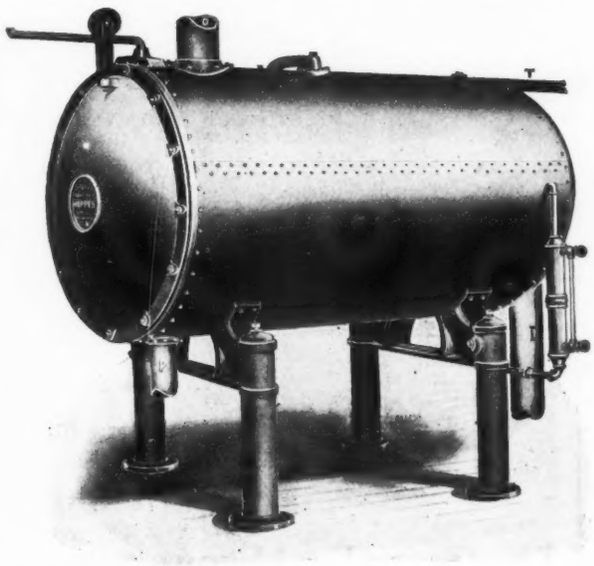

If so, you can save considerable floor space by installing a Hoppes Feed-Water Heater with pipe leg supports as shown in cut opposite. This device permits of locating heater directly over the boiler feed pump, requiring practically no extra floor space for heater, and is a great advantage and convenience in power plants where space is limited for the installation of auxiliaries. Hoppes Heaters are equipped with sockets and flanges for pipe leg supports without extra charge when specified.

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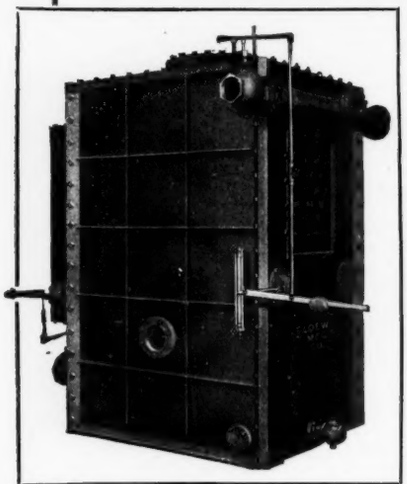
The First Precaution

against boiler explosion is the installation of

Loew Feed Water Heaters



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Simple in construction and built to utilize the full efficiency of the exhaust steam.

Occupy minimum space and secure maximum heating capacity in shortest possible time.

No clogging of Filterbed.

Easy to get at and clean all parts of Loew Heaters.

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The Otis Tubular Feed Water Heater Oil Separator, and Purifier

will coin your exhaust steam into good hard cash, protect your boiler from expansion and contraction strains and require less attention than any other heater of its capacity.

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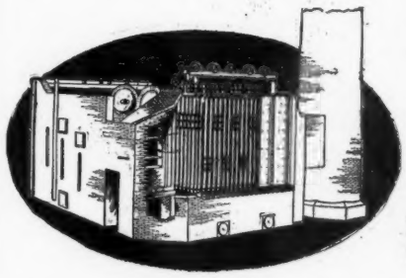

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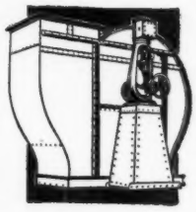

Include the Green Fuel Economizer, which recovers the waste heat in flue gases for heating water; Green's Air Heater, which recovers such heat for warming the air for all drying and heating purposes; Green's Fans, Blowers and Exhausters, used for heating and ventilating, mechanical draft, conveying materials, etc., and the Green Patent Heating Coil, used with live or exhaust steam or hot water for heating air and with cold water for cooling air. Our apparatus is specially designed for particular purposes and is applicable to every case where water or air is to be heated by waste heat in flue gases or exhaust or live steam or where air is to be moved.

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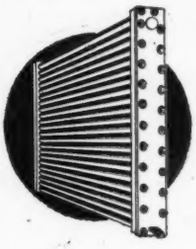

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144

Harrisburg Feed Water Heaters

Of Pure Seamless Copper Coils. Guaranteed to be the most effective, most durable and cheapest heater manufactured.

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COPPER, IRON AND BRASS PIPE COILS AND BENDS OF ANY DESIRED SHAPE

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The Cost Of Exhaust Should Never Be Lost

It is too big an item to waste and

Patterson-Berryman Feed Water Heater

will turn it back into coal and declare handsome dividends in the form of elimination of scale, protection of your boiler, etc.

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It costs no more than less efficient types. It gives better and longer service than the most expensive. We recommend using a thermometer to prove our guarantees.

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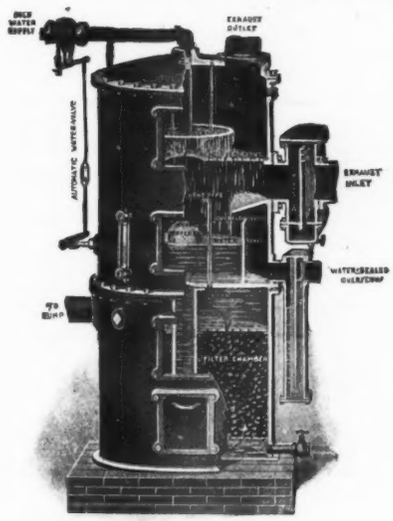

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Making One Dollar Save Ten

That's the regular work of the

National Feed Water Heater

and it does all its regular work and then works overtime beside.

It stands for economy of coal, space and repairs in thousands of boiler-rooms.

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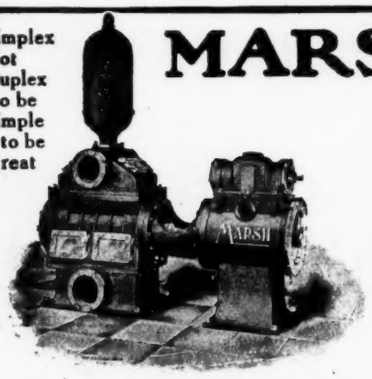

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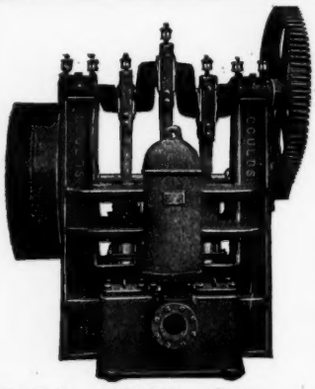

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EFFICIENT POWER PUMPS

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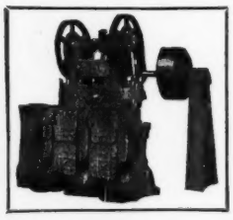

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For operation by any power. **Pumps**

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Agencies in Principal Cities
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over exhaust steam for heating and purifying feed water is simply a demonstrable fact in your plant or any other. *Write.*

The Eclipse Feed Water Heater & Purifier Co.
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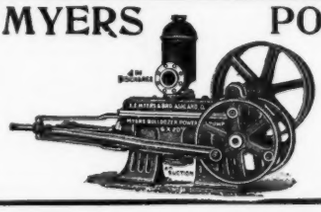
MYERS POWER PUMPS



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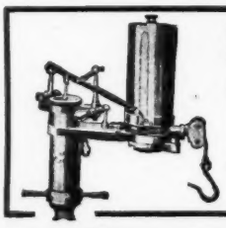

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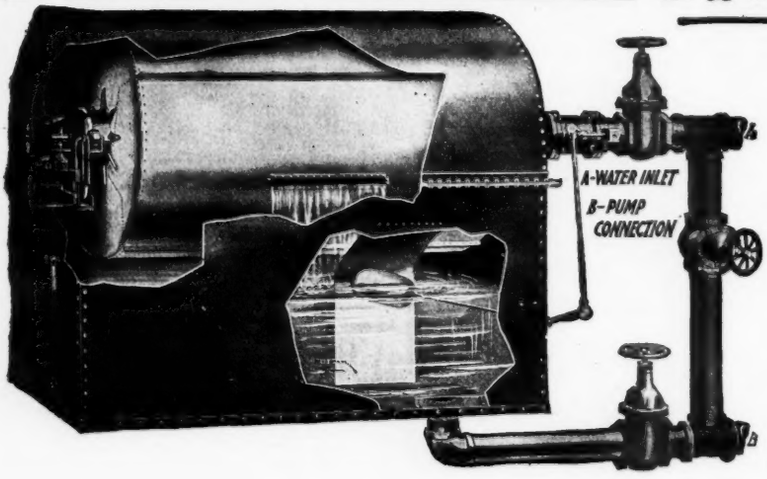

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Are you getting the best economy?
Is your coal best fitted for your purpose?
Can You Tell Your Evaporation?
A

DETROIT METER

Will Give You a Continuous Record of Your Boiler Feed Water

Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

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EDUCTOR **KOERTING** EDUCTOR

CONDENSER

VALVES FOR ALL PURPOSES.

VALVES FOR SUPER HEATED STEAM.

Its Usefulness

¶ This condenser can be applied to engines of any size, and works with absolute certainty under all conditions of load variation. The air and non-condensible gases are discharged with the water, and without the assistance of air pumps. In use by many lighting and power stations.

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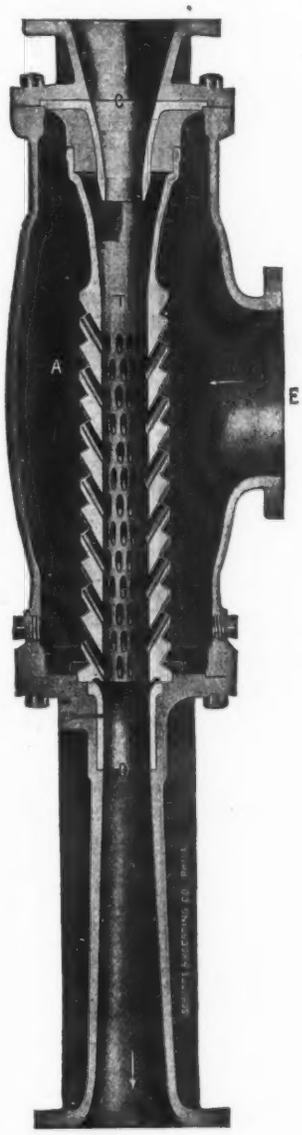
¶ Capable engineer to sell our condensers. Must be first-class salesman. Write, stating qualifications in detail, to our Philadelphia office.



Its Advantages

¶ Low cost of working.

¶ The actual H. P. required for working a Koerting Condenser Plant is less than one-half the power required for a condenser working with air pumps. It has no moving parts, therefore no wear and tear.

HIGHLY ADAPTED FOR TURBINES

VACUUM 93%

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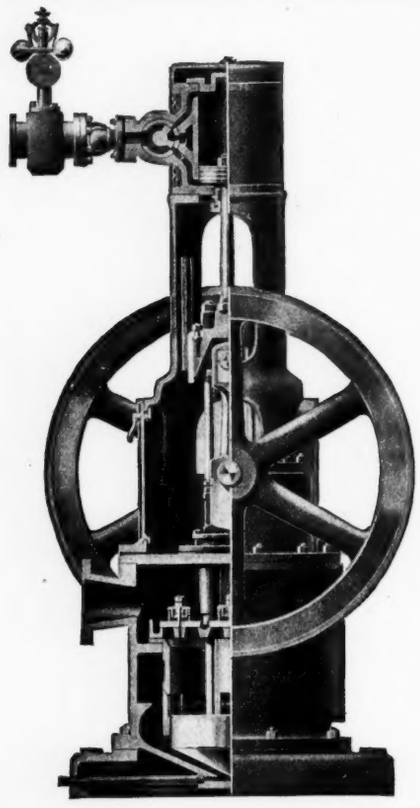


What Clear Inlets To The Pump Chamber Mean To The Condenser

The air pump is the vital element in the condensing outfit. If it is not of sufficient capacity or if the vapors are prevented from entering freely, there will be a low vacuum, no matter how much surface there may be in the condenser. The effects of a poor air pump are cumulative, for as soon as a small amount of air has collected in the condenser some of the tubes become air bound, putting part of the condensing surface out of service.

The air pump should dominate the condenser under all conditions. Even a small condenser will give fairly satisfactory results if it has a good air pump to keep it clear of air.

Now, the only thing that forces air from the condenser to the air pump is the excess of its own pressure over the pressure in the pump, and with a high vacuum this is very small. Nevertheless, most air pumps are so constructed that the vapors must lift heavy foot valves held down by several inches of water, before they can enter the air pump chamber. In ordinary air pumps, the water seems to have been made the first consideration, while the air was not thought of.

In the Wheeler-Edwards Patent Air Pump, the situation is reversed. When the bucket descends and the ports open, there is absolutely no obstruction between the condenser and the pump and the air has a perfectly free entrance to the barrel, while immediately afterward water is injected into the ports at a high velocity, drawing in still more air. Then as the pump rises the air is on top of the water and is forced out first through the head valves.

The results of this and other features is that the Wheeler-Edwards Air Pump can maintain a vacuum within a half inch of absolute and has frequently done this in actual service, working at full load.

This pump is made in all sizes and types for steam, electric and power drive, and is adapted for both surface and jet condensers. Write for special treatise, "103 P."

WHEELER

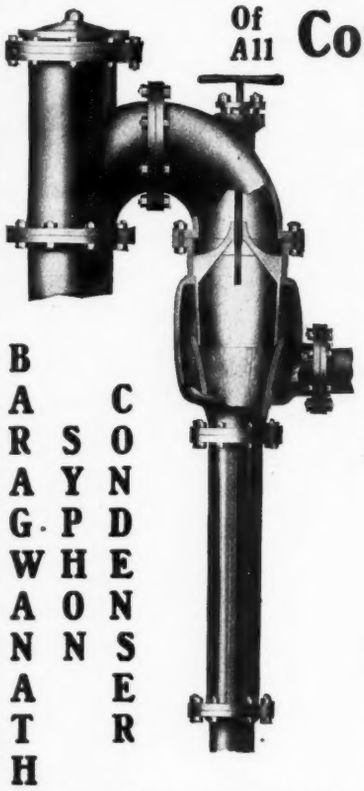
CONDENSER & ENGINEERING CO.

CARTERET, NEW JERSEY.

New York, Cincinnati, Chicago, Denver, Boston, Pittsburg, St. Louis, San Francisco, Atlanta, Houston, St. Paul.

(Builders of Wheeler Surface, Wet and Barometric Condensers, Wheeler-Volz Combined Surface Condensers and Feed Water Heater, Wheeler Feed Water Heaters, Barnard-Wheeler Cooling Towers, Wheeler-Edwards Air Pumps, Wheeler Centrifugal Pumps, Wheeler Rotative Dry Vacuum Pumps and Wheeler Multiple Effect and Evaporating Machinery). 16

The Most Economical Of All Condensers



BARAGWANATH SYPHON CONDENSER

The Baragwanath, uses very little water, syphons its own water safely up to 15 feet; requires no air pump; has an adjustable water nozzle, which provides for close regulation.

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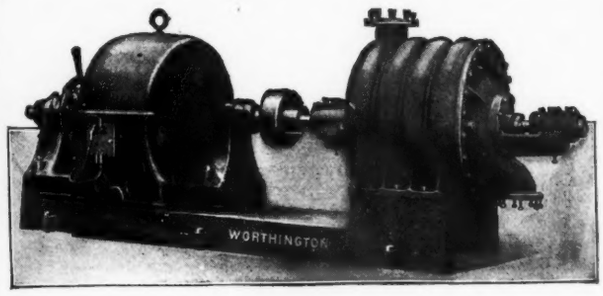
OUR TURBINE PUMPS



ARE SIMPLE
RELIABLE
EFFICIENT
WELL CONSTRUCTED

Require very little attention.
Built to suit your conditions.

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Alberger Condenser Co.

Condensers, Cooling Towers, Vacuum Pumps, Heaters

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Centrifugal, Volute, and Turbine Pumps

Alberger Pump Co.

Warren Steam Pump Co.

Warren, Mass.

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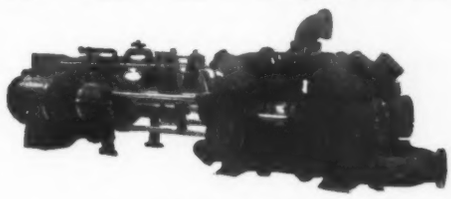

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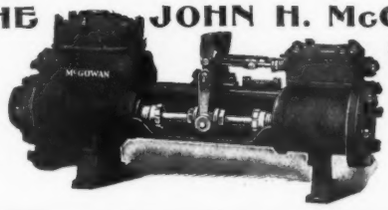

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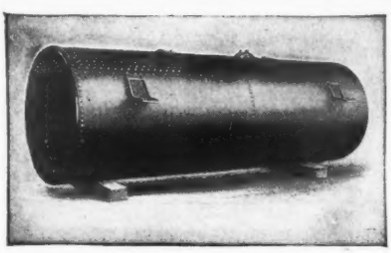

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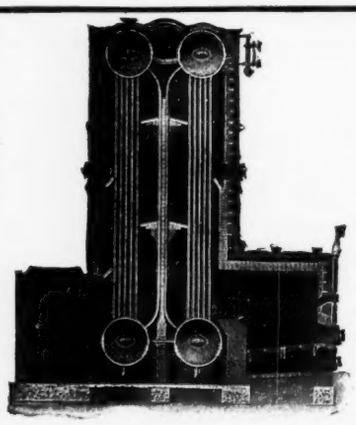

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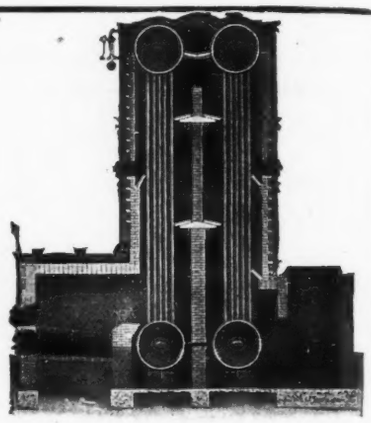

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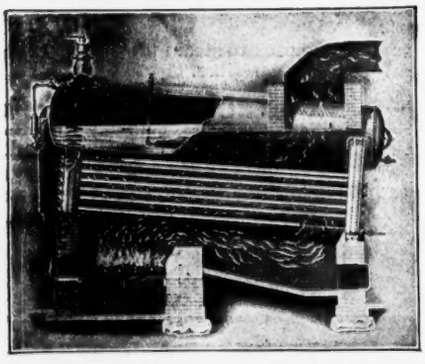

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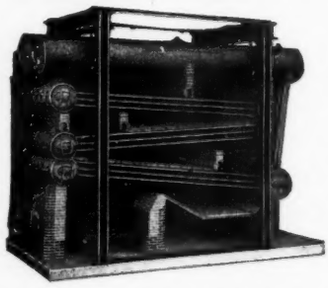

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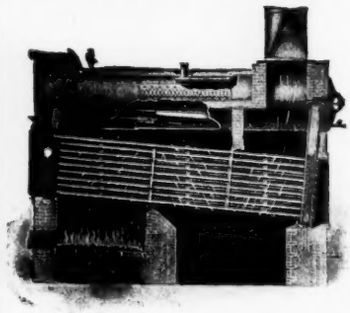

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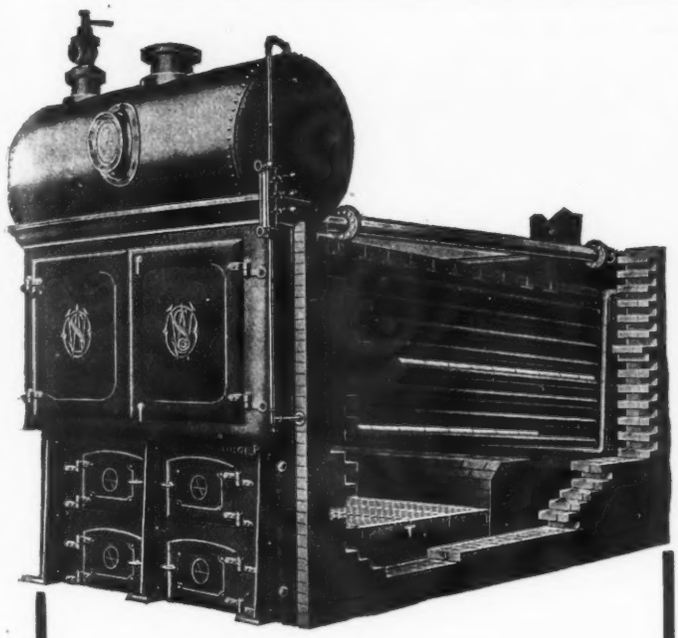

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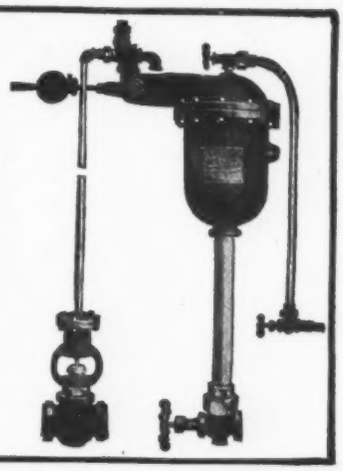

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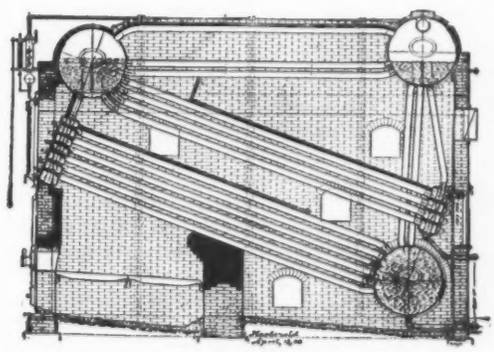

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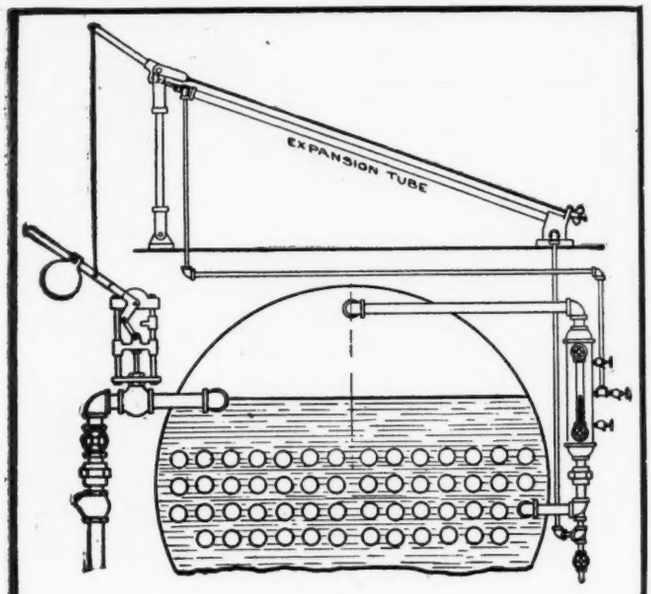

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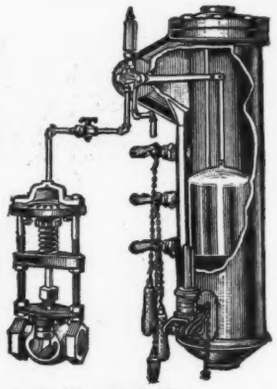

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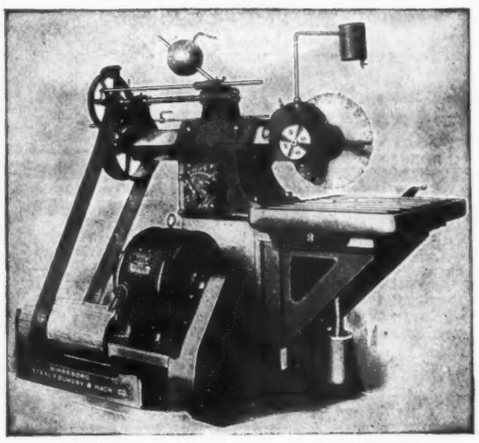

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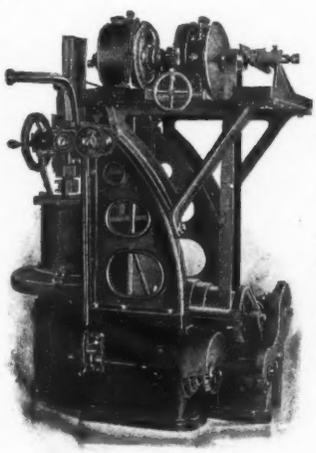

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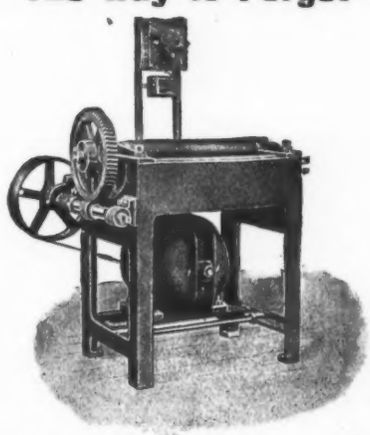

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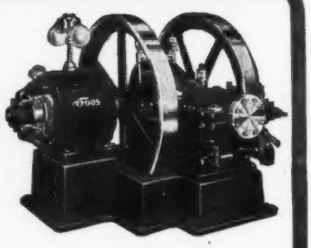

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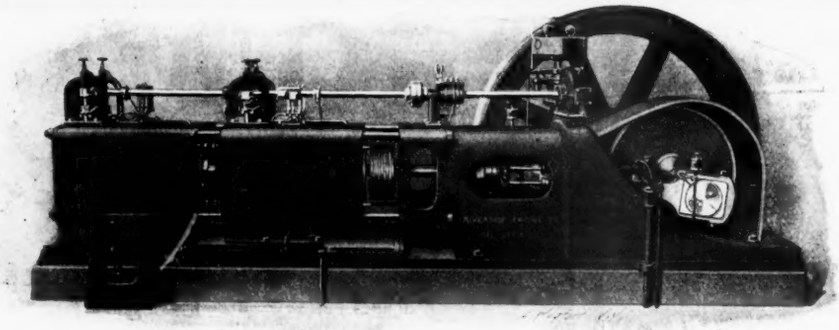

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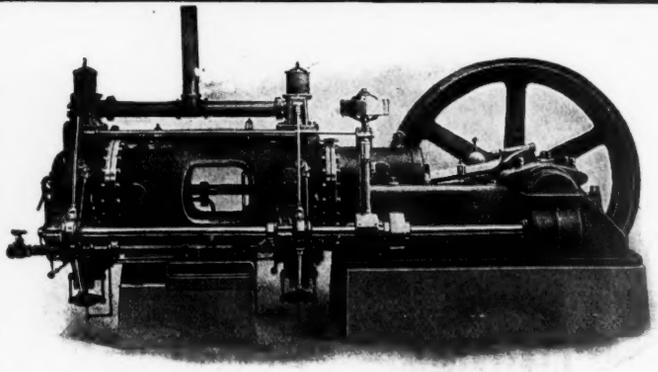

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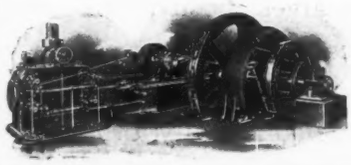

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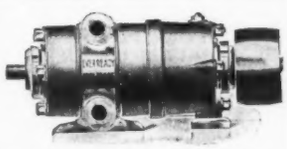

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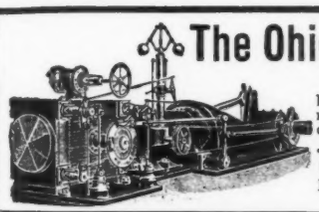

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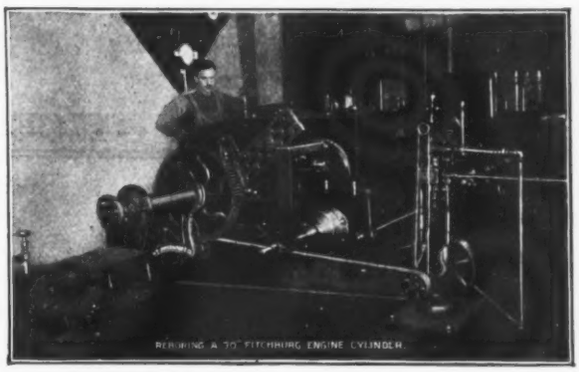

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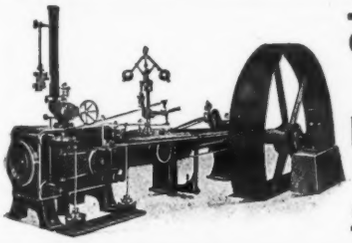

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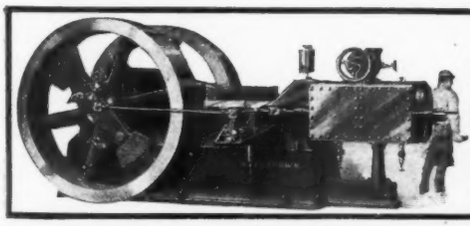

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Built of vertical and horizontal pattern; simple and compound steam ends; and air cylinders fitted with our patented grid-iron valves which make it possible to operate at higher speeds than with the usual form of air valve.

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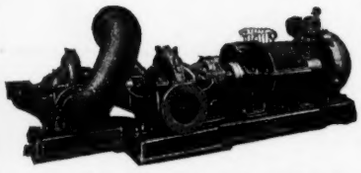

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Steam Turbine Motors
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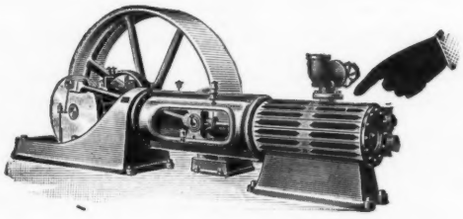

Attain the highest possible steam economy. Their perfectly balanced piston valves, positive adjustments to compensate for wear, and their close regulation are all features unequaled by any other engines. Catalog?

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One 18-inch by 42-inch girder frame engine, left hand, 90 revolutions, rated at 250 h.p.; wheel 14-ft. diameter by 48-inch face.

One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p.; wheel 14-ft. diameter by 33-inch face.

The above are **new** engines.

One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11-inches diameter. Wheel weighs 15,000 pounds.

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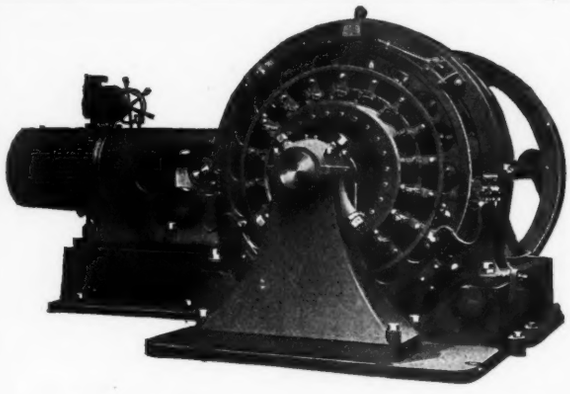

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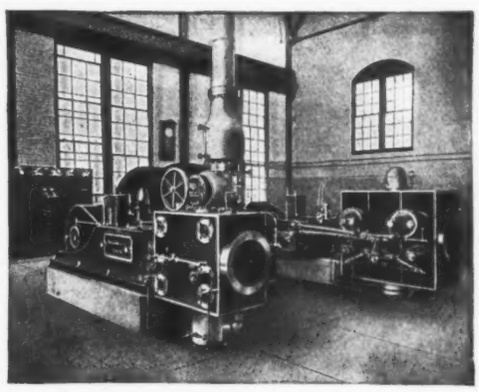

The Ball Engine Co.,

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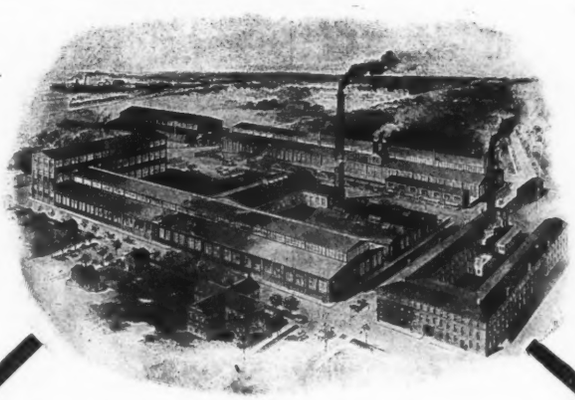

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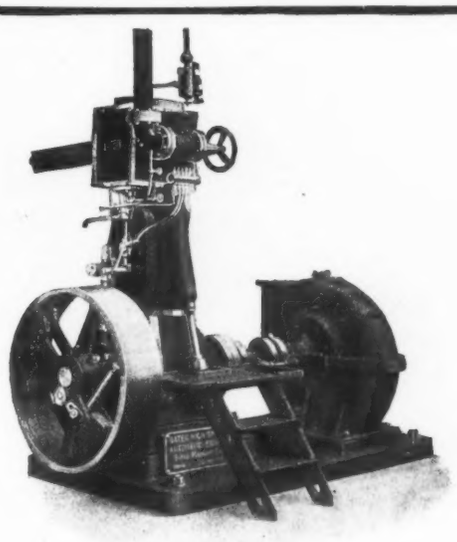

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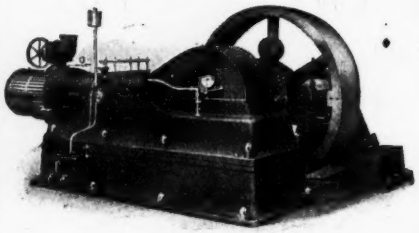

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Skinner Engines

CENTER CRANK
SIDE CRANK
SINGLE and FOUR VALVE

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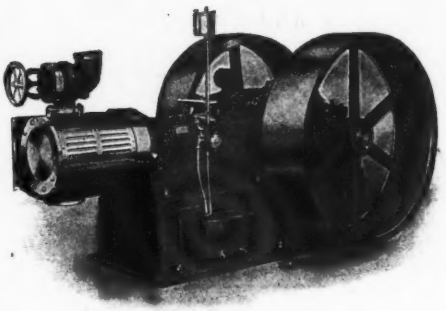

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BUILDERS OF HIGH CLASS

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HIGH IN DUTY, SUPERIOR IN REGULATION
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CORRESPOND WITH US BEFORE PURCHASING
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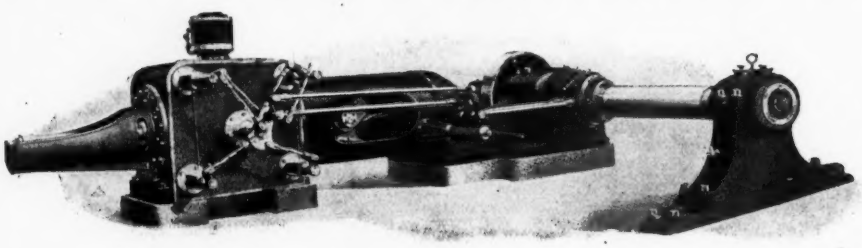
The Perfect High Speed Corliss Engine



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The Engine that lasts longer and gives more satisfaction per day than any other.

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How About Adjustments?

How many adjustments does the average steam engineer have to watch and regulate?

How many lubricators, drip cups and bearing gauges require his daily or hourly attention?

How much time is spent in keeping bearings adjusted for wear? How often is it necessary to shut down to "doctor" a bearing adjustment?

How long would the average generating set run without attention to some adjustment?

How many engineers realize the entire freedom from troublesome adjustments with the horizontal Curtis Steam Turbine Generating Set?

Do You?

Figure it out from these facts:

In the turbine there are either two or four self-aligning main bearings supplied with oil by means of chains, or in some cases, a small self-contained pump, and outside of the main bearings there are a few small bearings in connection with the governing mechanism, and in some cases with the oil pump.

All governor adjustments are correct when the machine leaves the factory and need no attention after machine is first started.

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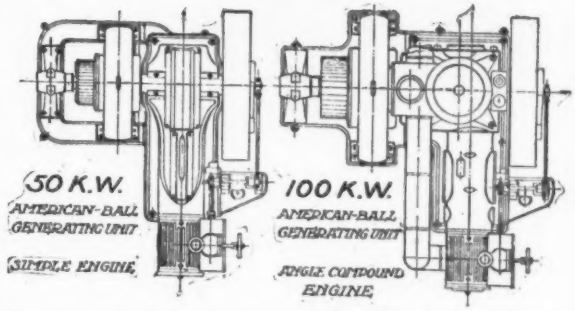
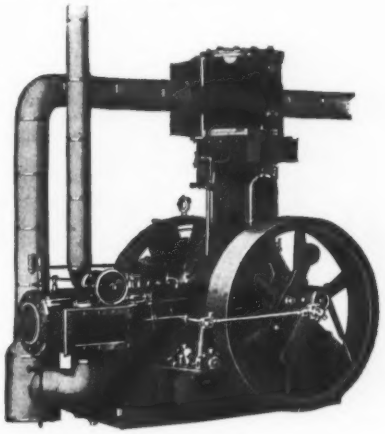


These two generating units, shown on the same scale, merely indicate how much space can be saved by installing

THE AMERICAN-BALL ANGLE COMPOUND ENGINE

in preference to a simple engine. It will be noticed that a 100 K. W. Generator driven by our Angle Compound occupies practically no more space than a 50 K. W. Generator driven by a simple engine. This American-Ball Angle Compound Engine goes into much smaller space than a tandem or cross-compound.



So much for space saving. Steam saving is another feature in which these Angle-Compounds have proven their merits. Their steam economy is equal to or better than that of any other high speed single valve engine of equal power.

If you appreciate a carefully designed and built engine, one that is compact, closely governed, economical and at all times dependable, we are ready to meet your requirements.

Write for catalog.

AMERICAN ENGINE COMPANY
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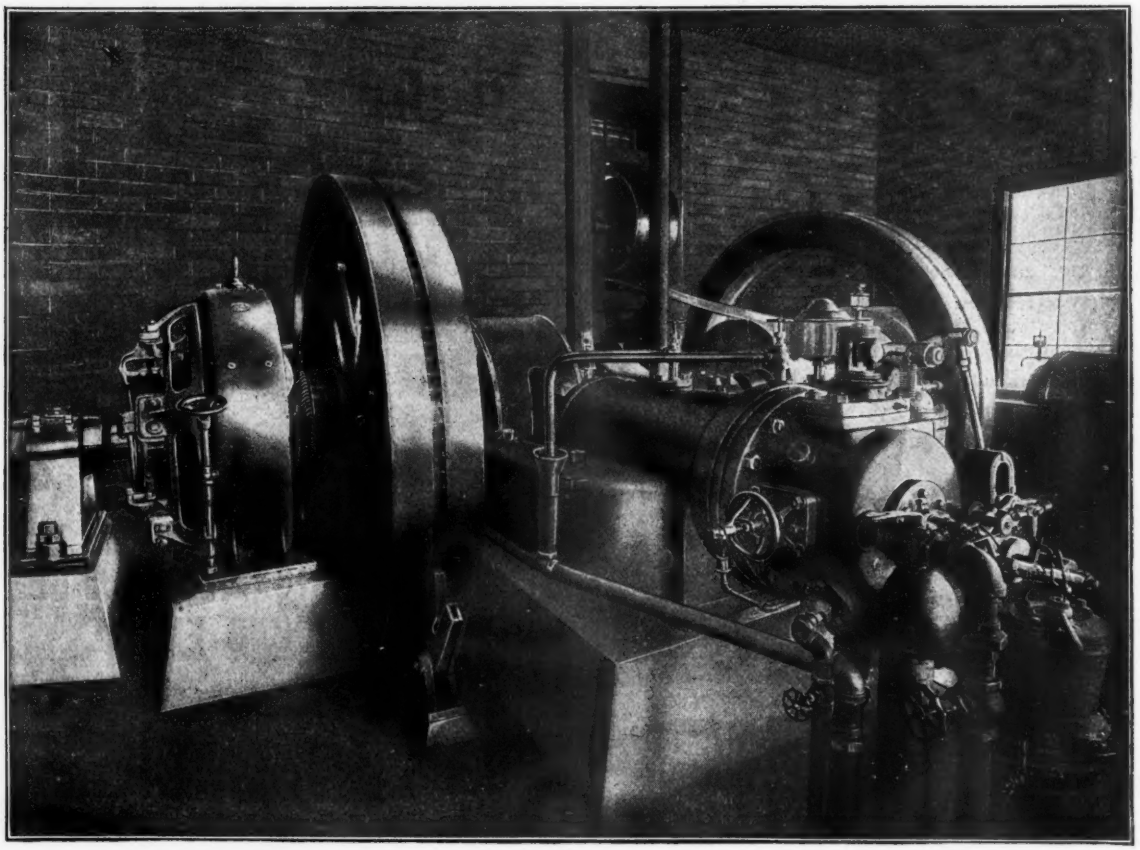
BOUND BROOK, NEW JERSEY No. 9



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The above cut shows one of the direct connected units in the Power Plant of the M. & St. L. R'y shops—where we have four different Engines.

"This Engine ran day and night without a single stop for 92 days—when shut down for examination was in perfect condition."—*From operator's report.*

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when you think of the yearly oil contracts you've signed—that is, after you have once tried, and seen the superiority of

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the world-greatest lubricant that contains no fats, rosin, acid, talc, graphite, etc., to get gummy and clog bearings, or to melt and run away. Keystone lasts 50 times as long as oil, it overcomes friction and saves anywhere from 25 to 75% in power. Oil users are money wasters but Keystone users are getting all that's coming to them. Why not join the Keystone Economy Club?

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One spool gives you all sizes that you require for your large and small valves.
Bear in mind the fact that heat does not affect PALMETTO, and once a valve is packed with it, it stays packed.
It comes braided round and square above $\frac{1}{4}$" for the piston rods.
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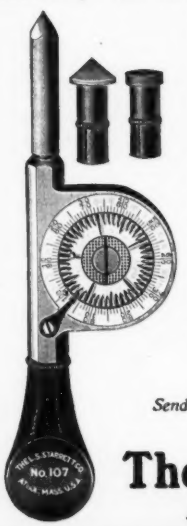

No. 107.—Has all the good points of the above, and in addition has a hard rubber handle for insulation when used on electrical machinery. It also automatically registers the number of revolutions up to 5,000, thus relieving the mind from keeping count.

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